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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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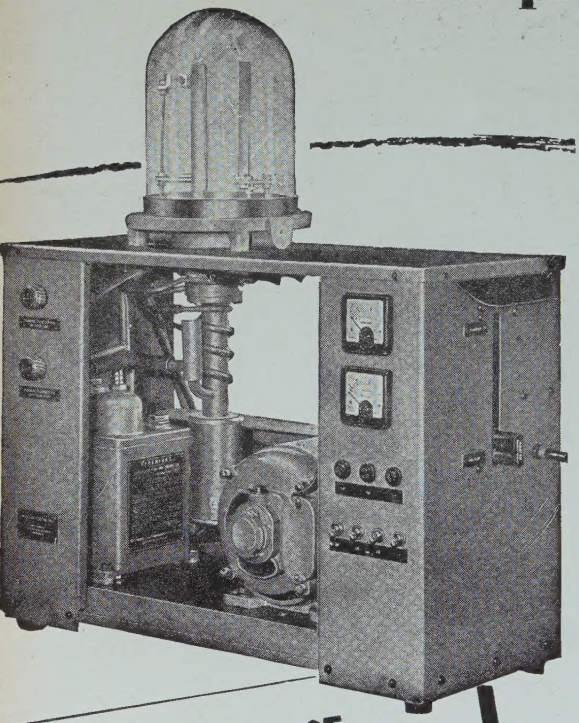
ABSTRACTS 4083–5199

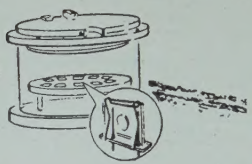
VOLUME 57 **MAY 1954** NUMBER 677

A *VERSATILE* experimenta

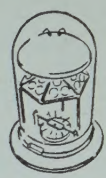
and pre-production researc

vacuum coating un





Evaporation or sputtering of H.F. quartz crystals with frequency control.



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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) an the Supplement published with the Index to Volume 56 (1953). Reprints of the List of Journals (1953) and th Supplement (1953) can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, pri 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted f errors.

Commonwealth Sci. Industr. Res. Org., Div. of Metrology Tech. Pap.	*Technical Paper, Division of Metrology. Commonwealth Scientific and Industri Research Organization, Australia.* Melbourne.
Glas- u. Hochvakuumtechnik	*Glas- und Hochvakuumtechnik.* [Article reprinted in *Entwicklungsber. Siemens Halske.*]
J. Mysore Univ.	*The Half-Yearly Journal of the Mysore University. Section B—Scienc including Medicine and Engineering.* Mysore University, Mysore.
SEG Nachr.	*SEG Nachrichten.* Standard Elektrizitäts-Gesellschaft AG., Hellmuth-Hirt Strasse 42, Stuttgart-Zuffenhausen.
SEG Nachr. Beiheft	*SEG Nachrichten Beiheft.* Standard Elektrizitäts-Gesellschaft AG., Hellmut Hirth-Strasse 42, Stuttgart-Zuffenhausen.
Tekn. Sirk. TelegrStyr. [*Oslo*]	*Tekniske Sirkulaerer Telegrafstyret.* Direction Générale des Télécommunicatio de Norvège, Oslo.

Erratum

Abstr. 1993 (1954) line 7: *for* $\mathfrak{g}^{ik}$, $k = 0$ *read* $\mathfrak{g}^{ik}{}_{,k} = 0$

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unles otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which th original article was published.

Abstr. 5721 (1952): **43,** 1231 (*Dec.*, 1953).
Abstr. 362 (1953): **22,** 573 (*March*, 1954).
Abstr. 2326 (1953): **43,** 1231 (*Dec.*, 1953).
Abstr. 2327 (1953): **43,** 1231 (*Dec.*, 1953).
Abstr. 2671 (1953): **93,** 1434 (*March* 15, 1954).
Abstr. 3990 (1953): **43,** 1231 (*Dec.*, 1953).
Abstr. 4183 (1953): **93,** 1434 (*March* 15, 1954).
Abstr. 4693 (1953): **14,** No. 1–2, 86 (1954).
Abstr. 5864 (1953): **93,** 1434 (*March* 15, 1954).
Abstr. 5986 (1953): **43,** 1231 (*Dec.*, 1953).
Abstr. 6170 (1953): **93,** 1434 (*March* 15, 1954).
Abstr. 6850 (1953): **93,** 1434 (*March* 15, 1954).
Abstr. 7606 (1953): **43,** 1231 (*Dec.*, 1953).
Abstr. 136 (1954): **9,** 146 (*Jan.–Feb.*, 1954).
Abstr. 962 (1954): **43,** 1231 (*Dec.*, 1953).
Abstr. 1006 (1954): **93,** 1434 (*March* 15, 1954).
Abstr. 1681 (1954): **93,** 1434 (*March* 15, 1954).
Abstr. 1755 (1954): **93,** 1434 (*March* 15, 1954).
Abstr. 2824 (1954): **22,** 573 (*March*, 1954).
Abstr. 3469 (1954): **9a,** 184 (*Feb.*, 1954).
Abstr. 3472 (1954): **93,** 1434 (*March* 15, 1954).

MATHEMATICS 51

512.9

4083. Spherical tensors in physics. M. E. ROSE. *Proc. Phys. Soc.* [*London*] *A*, **67**, 239–47 (*March*, 1954).

Irreducible tensors in the spherical coordinate representation, in contrast to the cartesian representation, are discussed. The greater simplicity of this representation, especially when one deals with eigenstates of particles or radiation fields of sharp angular momentum, is emphasized. Applications to the theory of β-transitions, γ-ray emission, angular correlation and the static interaction of a multipole with a surrounding spin system or field are considered. A.

517.512.2

4084. A graphical method of summing Fourier series. F. HUERTA AND J. M. CASALS. *An. Real. Soc. Españ. Fis. Quim.*, **48**(A) 238–43 (*July–Aug.*, 1952) *In Spanish.*

Values of $A \cos(kn\,6°)$ and $B \sin(kn\,6°)$ appear on a table as distances from a central line, and these distances are summed graphically. A. R. STOKES

517.6

4085. An approximate method of evaluating integral transforms. A. H. ZEMANIAN. *J. appl. Phys.*, **25**, 262–6 (*Feb.*, 1954).

A new approximate means of evaluating integral transforms is developed. The process, which is very simple and quite general, has been applied to the Fourier, Laplace, Mellin and Hankel transforms. The method may also be successful as a numerical means of evaluating an integral which has a highly oscillatory term in its integrand. A.

517.9 : 533.7

4086. Use of restricted variational principles for the solution of differential equations. P. ROSEN. *J. appl. Phys.*, **25**, 336–7 (*March*, 1954).

A technique is given by which nonlinear differential equations may be solved approximately, using variational principles for which certain restrictions are made. Ordinary first- and second-order equations are discussed in detail. The method is extended to encompass partial differential equations and applied to the Boltzmann transport equation. A.

517.93

4087. Solution of nonlinear differential equations by the reversion method through the first thirteen terms. G. I. COHN AND B. SALTZBERG. *J. appl. Phys.*, **25**, 252–4 (*Feb.*, 1954).

By the use of the reversion method, certain types of ordinary nonlinear differential equations can be reduced to a set of ordinary linear differential equations which may be conveniently solved by the Laplace transform. The first thirteen equations of this reduced set are tabulated in this paper. A.

518.4 : 538.566

4088. Graphs of the function $E(N,\delta) = \sum_{n=1}^{N} n^{-1/2} e^{in\delta}$. J. RUSSEK AND V. TWERSKY. *New York Univ.* (*Washington Sq. Coll.*) *Math. Res. Group, Res. Rep., EM*-49, 22 *pp.* (*Feb.*, 1953).

The function $E = C + iS$ of the title arises in diffraction problems involving gratings and in allied aerial problems. Curves of S *v.* C are presented as functions of δ for $N = 1$ to 10 and $N = 10^2, 10^3, 10^4$. It is found that $|E|_{max}$ always occurs for $\delta = 0$, and the curves from $\delta = 0$ to 2π show N–1 loops; for large N, $|E|_{min}$ occurs for $\delta = \pi$. Curves of C and S as functions of δ are also included. A.

518.43 : 621.3.018

4089. Geometrical integration of nonlinear differential equations of the second order with a second member. G. CAHEN. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **4**, 44–50 (*Jan.*, 1954) *In French.*

Methods are presented for tracing the curves which are the integrals of the equation $x'' + b(x)x' + r(x) = g(t)$. Extension is indicated to equations involving terms $a(x)x'^2$ or $c(x')$. These nonlinear equations arise, for example, in various types of relaxation oscillations. L. S. GODDARD

518.5

4090. A mathematical basis for an error analysis of differential analyzers. K. S. MILLER AND F. J. MURRAY. *J. math. Phys.*, **32**, 136–63 (*July–Oct.*, 1953).

In the solution of the equation

$$F_i(x_1, \ldots x_n, x_1, \ldots x_n, t) = 0,$$

where $i = 1, \ldots n$, by a differential analyser, errors may arise (1) because the machine actually solves $G_i = 0$, (2) because there are, from time to time, disturbances in the solution of $G_i = 0$. A method is described whereby the effects of (1) can be reduced by suitable choice of restricted regions for solution. N. L. JOHNSON

518.5 : 537.533 : 621.384.62 : 621.317.79

4091. A computer for solving some problems in connexion with travelling-wave particle accelerators. M. C. CROWLEY-MILLING. *J. sci. Instrum.*, **31**, 100–4 (*March*, 1954).

Describes the construction and operation of an analogue computer, designed to perform calculations of energy gain and to plot relative phase curves of particles in linear particle accelerators. It was constructed to solve problems concerned with bunching sections for electron accelerators, but only slight modification is necessary to make it suitable for calculations concerned with charged particles other than electrons. A.

519.2

4092. Estimation of correlation coefficients from scatter diagrams. G. R. SUGAR. *J. appl. Phys.*, **25**, 354–7 (*March*, 1954).

Theoretical relations between statistical scatter diagrams of two random variables and their joint probability density functions are used to derive a

simple method of estimating correlation coefficients. The cases considered are those of variables with Gaussian and Rayleigh distributions. Theoretical curves and experimental scatter diagrams are given for each case. Some factors which may influence the accuracy of the proposed method are discussed, and it is concluded that the errors in estimating correlation coefficient will be of the order $\pm 0{\cdot}1$. A.

519.25 : 537.3 : 621.391

4093. Information loss attending the decision operation in detection. D. MIDDLETON. Letter in *J. appl. Phys.*, **25**, 127–8 (*Jan.*, 1954).

The note aims to provide a measure of the information loss attending the making of a definite binary decision, and to discuss its relation to the type of statistical test employed in the detection process.

T. J. REY

519.25 : 537.3 : 621.391 : 621.376

4094. Discussion of "statistical criteria for the detection of pulsed carriers in noise. I–II". D. MIDDLETON, W. PETERSON AND T. BIRDSALL. Letter in *J. appl. Phys.*, **29**, 128–30 (*Jan.*, 1954).

See Abstr. 3794 (1953). The Neyman–Pearson and Ideal observers are compared, subject to the same value of the sum $\alpha p + \beta q$, where α and β are type I and II probabilities, respectively, and p and q are I fixed. T. J.

519.281.2 : 53

4095. On simplifying the reduction by least squa of angular distribution experiments in nuclear phys P. C. PRICE. *Phil. Mag.*, **45**, 237–45 (*March*, 1954

The reduction of angular distribution experime by the method of least squares is often very laborio An experimental procedure is described wh simplifies the computations by using a particular of experimental angles and of relative weights of observations at each angle. The method of calcu tion is an application of Gauss' Formula of Numer Integration; a proof that this method is a "le squares" reduction is given in an appendix. Fo figure tables are included to facilitate the use of method.

51

4096. The calculus of variations in the theory types and varieties. T. DE DONDER. *Bull. Ac Roy. Belgique Cl. Sci.*, **39**, *No.* 3, 255–6 (1953) *French.*

The notions of stationary state and stability extended to new types which are derived by quanti tion. L. S. GODDA

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.2 : 535.317.1

4097. On telescopic star images. E. H. LINFOOT AND E. WOLF. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 4, 452–69 (1952).

Diffraction theory is applied to discuss the properties of the polychromatic, three-dimensional star images formed by refracting doublet objectives. The effects of the secondary spectrum on the light distribution in the diffraction image and on the position of best focus are examined quantitatively in two special cases: (A) an $f/15$ refractor of $24\frac{7}{8}$ in. aperture, (B) a similar refractor of one-third the linear dimensions. The image formed by an $f/15$ reflector working without central obstruction (Case R) is analysed for comparison purposes. A.

522.21 : 522.617

4098. The spectrographic arrangement of the Bergedorf 1 m reflecting telescope. P. WELLMANN. *Z. Astrophys.*, **33**, *No.* 2, 115–19 (1953) *In German.*

A brief description is given of the new Cassegrain optical system, of the spectrograph and of the drive of the 1m reflector. M. W. OVENDEN

522.6 : 535.33.07

Determination of the resolving power of a spectrograph by means of absorption lines and of emission lines. *See Abstr.* 4324

522.6 : 551.501.8

4099. The application of radar to astronomy and meteorology. J. VAN BLADEL. *Bull. Sci. Assoc. Ingen. Montefiore* [*A.I.M.*] **66**, 635–57 (*July–Aug.–Sept.*, 1953) *In French.*

Preliminary consideration is given to the equations relating the received power from the reflected signal to the transmitter power. The possibility of receiving echoes from various celestial bodies is discussed a a table is given showing the size of the well-kno planets and distance from the earth. The possibi depends on the ratio σ/D^4 where σ is the area of reflecting surface and D the range. This ratio greatest for the moon, being $0{\cdot}5 \times 10^{-23}$ and the ec time 2·56 sec. For modern radar this figure sho be about 10^{-20}. The special case of meteorites discussed where ionization produces other signa The determination of a meteorite trajectory described. In meteorology radar is used for locati rainstorms and clouds and mathematical expressio are given. The particle size varies considerably w the cloud formation, the particle diameter bei $6{\cdot}4\,\mu$ for cumulus and $250\,\mu$ for cumulo-nimbu For this a wavelength 0·86 cm gave better resu than 1·25 cm. 51 references are given. B. B. AUST

522.

4100. The deformation of a photographic plate in Schmidt camera. W. M. SHEPHERD. *Monthly N Roy. Astron. Soc.*, **113**, *No.* 4, 450–4 (1953).

When a flat photographic plate is bent on a spheric former, as in the Schmidt camera, strains are produc in the plate which must be allowed for in maki measurements on the exposed plate. The necessa corrections are obtained. In the case of celluloi which has a Poisson's ratio of about $\frac{1}{3}$, these take particularly simple form.

522.615 : 523.841

4101. A photoelectric stellar photometer with a amplification: the light-curve of the eclipsing variabl A K Herculis. D. LABS AND J. STOCK. *Z. Astrophy* **33**, *No.* 1, 74–7 (1953) *In German.*

A light-modulated photoelectric photometer ar

amplifier is described in which the a.c. amplification is tuned to the frequency of light-modulation viz. 500 c/s. The instrument has been used at the Cassegrain focus of the Hamburg 60 cm reflector to obtain a light-curve of the W Ursa Major star, A K Herculis, which is reproduced. D. R. BARBER

522.615 : 535.247.4

4102. Simple and accurate method of voltage stabilization for direct current compensation photometers. M. SAUER. *Optik*, **11**, *No.* 1, 18–21 (1954) *In German.*

The use of gas-filled photocells or photomultiplier cells for photometry suffers from the disadvantage that a very constant voltage is required. The author describes a simple and accurate photoelectric stellar photometer, with a compensator for voltage fluctuation depending on the linearity of the magnification with applied voltage. J. W. T. WALSH

523.161

4103. On the formation of interstellar dust. F. D. KAHN. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 5, 518–26 (1952).

A process is suggested which leads to the formation of elongated and electrically polarized ice grains in interstellar space. Some values are found for the dipole moment to be expected on grains of different sizes and shapes. A.

523.161

4104. On the size of interstellar clouds. D. TER HAAR. *Z. Astrophys.*, **32**, *No.* 4, 251–6 (1953).

It is suggested that the size of interstellar clouds is determined by the requirement that they are the largest units inside which no turbulence will occur. From this assumption it follows that the mean density of a cloud will be inversely proportional to its diameter, as observed. The life-time of interstellar clouds with respect to turbulent disrupture, differential rotation in the galactic gravitational field, field fluctuations due to chance collisions with stars, or collisions with other clouds is estimated. A.

523.161

4105. An analysis of the relative motions in interstellar gas. A. SCHLÜTER, H. SCHMIDT AND P. STUMPFF. *Z. Astrophys.*, **33**, *No.* 3, 194–210 (1953) *In German.*

Using Adams's published data (1949) a study has been made of the behaviour of the interstellar Ca (*H*, *K*) lines in the spectra of 300 early-type stars. The deduced Doppler velocities indicate the existence of discrete Ca-clouds, with variable line-intensity values for those stars in their immediate neighbourhood. A well-marked cloud-structure is revealed in Cygnus (R.A., $19^h\,30^m$ to $21^h\,30^m$; Dec., $+35°$ to $+50°$). D. R. BARBER

523.161 : 533.2

4106. The expansion of a gas-cloud into a vacuum. R. C. KHARE. *Z. Astrophys.*, **33**, *No.* 4, 251–66 (1954).

Copson's work [Abstr. 2315 (1951)] on the one-dimensional expansion into a vacuum, of a cloud of monatomic gas has been extended to the case of any real gas. A general solution of Riemann's equations involved in the problem has been obtained in the form of hypergeometric series and it is shown that the known solution for positive integral value of $n = 3 - \gamma/[2(\gamma - 1)]$, ($\gamma$ being the ratio of specific heats) is deducible from it. It is further pointed out that the solution obtained by Copson [Abstr. 3941 (1953)] for non-integral values of n is the same as the one given in the present paper and therefore is a particular case of the more general solution referred to before. Initially the cloud is taken to be at rest and lies in the region $x \leqslant h$; $x \geqslant h$ being vacuum into which it expands after the motion has started. The cloud is assumed to be homogeneous except for a boundary layer of arbitrary thickness. Motion starts in the non-homogeneous layer and spreads into the homogeneous part. The face of the cloud is found to be a seat of shock conditions. The boundary separating the homogeneous and the non-homogeneous portions moves into the homogeneous region with the local velocity of sound in the homogeneous gas at rest. The face of the cloud advances into the vacuum with $2/(\gamma - 1)$ times the speed of sound in the homogeneous gas at rest, γ having the same meaning as before. For monatomic gas the velocity of the face reduces to three times that of the local velocity of sound. Copson's results for the monatomic gas are confirmed and shown to be particular cases of those obtained in the present more general investigation. A.

523.165

4107. The radio emission of galactic or extragalactic origin. M. DUFAY. *J. Phys. Radium*, **15**, 50–7 (*Jan.*, 1954) *In French.*

A brief historical summary of early observations and theories is followed by an account of recent work relating to the identification, the apparent diameters, the emission spectra and the galactic distribution of the discrete sources. The origin of the continuous galactic radiation (from interstellar gas and/or unresolved discrete sources) and the observations of the neutral hydrogen radiation at 1420 Mc/s are discussed. A bibliography of about 60 entries is included. M. W. OVENDEN

523.165

4108. On the nature of the discrete radio sources. R. Q. TWISS. *Phil. Mag.*, **45**, 249–58 (*March*, 1954).

The theory that the galactic radio noise emitted by the discrete sources is due to the interaction of a local magnetic field and cosmic-ray electrons is tested quantitatively for the source in Cassiopeia. It is shown that the average magnetic field must be of the order of 0·01 gauss, which is approaching the upper limit imposed by energy considerations. At frequencies below 15 Mc/s resonant reabsorption of the r.f. energy becomes important and if the theory is valid the r.f. power received at the earth should vary at least as rapidly as $\nu^{5/2}$ below a critical frequency in the range 10–20 Mc/s. A.

523.165 : 537.591.1

Theory of origin of cosmic rays. *See Abstr.* 4668

523.53

4109. The velocity distribution of sporadic meteors. III. Calculation of the theoretical distributions. J. A. CLEGG. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 4, 399–413 (1952).

The radio echo measurements of the velocities of sporadic meteors have been described in Pts I and II

of this series of papers [Abstr. 6997–8 (1952)]. To assess the significance of the results of these investigations it is necessary to establish a relationship between the true geocentric velocity distribution and that observed experimentally. This relationship depends essentially on the effective field of view of the radio echo apparatus, which is determined by the directional characteristics of the aerial. The present paper describes a general method of estimating the field of view of any aerial system, and hence of predicting the ratio of true to observed hourly numbers, for particles of different velocity and flight direction. It deals specifically with the measurements described in Pts I and II. Theoretical curves are derived, showing the velocity distributions that would be expected in these experiments, on the assumption that all sporadic meteors move in parabolic orbits and approach the earth from random directions. A.

523.53

4110. The velocity distribution of sporadic meteors. IV. Extension to magnitude +8, and final conclusions. M. Almond, J. G. Davies and A. C. B. Lovell. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 4, 411–27 (1953).

Presents the results for meteors of magnitude down to +8. The results are similar to those described previously, and give no evidence for a significant hyperbolic velocity component. The scale of magnitude for the entire series has now been established, and the velocity distribution shows no change with meteor magnitude. Evidence is given that nearly 90% of sporadic meteors must be moving in elliptical orbits with periods of about two years, and that the remainder have velocities close to the parabolic limit. It is impossible to reconcile these results with the theory that sporadic meteors are moving with hyperbolic velocities from an interstellar origin. A.

523.671 : 535.338

4111. Conditions of emission, and origin of the 4050 Å group [in the spectrum] of cometary nuclei. R. Goupil and R. Herman. *Ann. Astrophys.*, **16**, *No.* 6, 444–65 (1953) *In French.*

A theoretical and experimental study has been made of the spectral bands between 3900 Å and 4100 Å, first observed in the spectra of comets, and whose origin is still uncertain. It is shown that in the laboratory discharge the presence of the radical CH is necessary for the production of the 4050 Å group of bands; and from considerations of potential surfaces of the hypothetical molecule, C_3, which has recently been identified tentatively [see also Abstr. 6415 (1953)], the rotational band-structure is explained. Theoretical computation of electronic transitions for C_3 yields a wavelength of 4050 ± 5 Å, in agreement with observation. A new empirical method is described for evaluating intensity distributions in the vibrational band-system of C_3.

D. R. BARBER

523.7 : 537.591.5

Solar magnetic moment and diurnal variation in cosmic-ray intensity. *See Abstr.* 4677–8

523.7 : 538.12

4112. Remarks on Hale's determination of the general magnetic field of the sun. H. von Klüber. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 5, 54[illegible] (1952).

A short discussion is given of the Zeeman patte[rn] of the Fraunhofer lines used by Hale in his de[ter]mination of the general magnetic field of the s[un], the object being to detect a possible system[atic] influence on his measurements arising from [the] various forms of pattern. Although considera[ble] more information is available now than was to H[ale] no trace of such an effect could be found.

523[illegible]

4113. Observation of the partial solar ecli[pse] (February 14, 1953) at the wave-length of 10 ce[n]timeters (3000 megacycles). K. Aoki. *Rep. Ionosph[eric] Res. Japan*, **7**, *No.* 3, 109–15 (1953).

The eclipse was observed at Tokyo for a fa[ir] quiet sun. Observed at this wavelength, the sun w[as] 5% larger than the visual disk and showed a li[mb] brightening. Asymmetry in the observed ecli[pse] curve is explained by a local bright region around [the] sunspots, which is interpreted as an excess of [free] electron densities in the chromosphere and [the] corona.

523[illegible]

4114. An experimental study of solar radio no[ise] storms. B. Vauquois, P. Coupiac and M. Laffineu[r] *C.R. Acad. Sci.* [*Paris*] **237**, 1630–2 (*Dec.* 21, 19[53]) *In French.*

An analysis is made of the directivity on vario[us] frequencies of the radiation of solar noise storm[s] associated with sunspots. Five suitable occasio[ns] occurred between April 1952 and April 1953 wh[en] only a single spot or a single group of spots w[as] active on the sun. The time of onset of a storm [at] each frequency was taken to be when the intens[ity] exceeded that of the mean intensity from the und[is]turbed sun. For each spot-group, the time of on[set] of the storm at various frequencies between 62 M[c/s] and 255 Mc/s was noted, and the longitude of t[he] spot at onset (referred to the central meridian) plott[ed] against frequency of observation. A definite relati[on] between longitude and frequency was found, t[he] relationship being similar for all five spot-grou[ps]. These observations are interpreted in terms of co[ne] of emission of radiation from the active areas ass[o]ciated with the spots, the cone angle being larger f[or] the larger frequencies. M. W. OVEND

523.7[illegible]

4115. An attempt to determine the distribution [of] the magnetic field strength over the area of a sunsp[ot]. E. H. Schröter. *Z. Astrophys.*, **33**, *No.* 1, 20–[35] (1953) *In German.*

Curves of equal field strength are derived on t[he] basis of 22 Zeeman spectra of a large sunspot, obtain[ed] in October 1951 with the Einstein tower telescope [at] Potsdam. Asymmetries in the observed splittings a[re] traced back to the Evershed effect. A comparis[on] of the curves with the outlines of umbra a[nd] penumbra on a direct solar photograph leads to [a] discussion of the indicated distortions as due [to] effects of guiding, seeing, and the methods used [in] reducing the observations. A. BE[ER]

523.746

4116. Prediction of the epoch of the next sunspot maximum. W. GLEISSBERG. *Z. Astrophys.*, **33**, *No.* 1, 1–8 (1953) *In German.*

On the basis of the author's previous contributions to the problem of predicting solar activity, a probability of 99% is calculated for the realization of the prediction that the time interval elapsed between the last and the expected next sunspot maximum will be smaller than the average of 11·1 years. Thus the next maximum should occur earlier than June 1958 (actually within the period August 1, 1957, to July 31, 1958). A. BEER

523.746

4117. On a solar index of spot-activity. U. BECKER AND K. O. KIEPENHEUER. *Z. Astrophys.*, **33**, *No.* 2, 132–41 (1953) *In German.*

It is shown how existing daily records of relative spot numbers and areas may be used to form an index of total sunspot activity (i.e. for the whole solar surface) which is independent of the effects of the sun's rotation period, and of the heliocentric distribution of the individual spot groups. D. R. BARBER

523.748 : 551.510.535

4118. Solar spicules and their role in solar phenomena. J. H. RUSH AND W. O. ROBERTS. *Trans Inst. Radio Engrs Prof. Group on Commun. Syst.*, **CS-2**, 24–8 (*Jan.*, 1954).

Spicules are very small, short-lived eruptive features on the sun. They occur in large numbers, and appear to be uniformly distributed over the polar regions where they have been observed. They are continuously active in these regions, and may be distributed over the entire sun. The spicules appear to project material away from the sun, and may be a principal source of material for the corona. Some lines of investigation suggest relations of spicules to the granulation observed on the disk of the sun, and to the recurrent ionospheric storms attributed to *M*-regions. A.

523.755

4119. A comparison of the intensities of infra-red and violet radiation from the solar corona at the eclipse of 1952 February 25. D. E. BLACKWELL. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 6, 652–64 (1952).

Measurements made in Khartoum at the total solar eclipse of 1952, February 25, show a considerable excess of infrared radiation in the solar corona at $2{\cdot}5R_\odot$ from the solar centre. It is shown that the infra-red excess supports the current theory of an F-corona caused by diffraction of sunlight by a cloud of interplanetary dust particles. Three models with widely differing distributions of dust are calculated, but it is not possible to distinguish between them by using existing infrared and visible data alone. A.

523.755

4120. The physical condition of the solar corona. C. W. ALLEN. *Rep. Progr. Phys.*, **17**, 135–53 (1954).

The observations from which the physical conditions of the corona may be derived are reviewed. The density distribution obtained from the light scattering of electrons is a straight mean. However, the corona is an irregular object and some attempt is made to determine the amount and the effect of the irregularity. A comparison is drawn between estimates of temperature by line breadth, density gradient, ionization and radio emission. Recent evaluations are given of the constants in the ionization formula. The excitations of coronal lines by collisions and by solar radiation are discussed quantitatively and lead to an excitation collision cross-section of approximately 2×10^{-17} cm^2. The estimate of the metal to hydrogen ratio in the corona is rather higher than in other astrophysical sources. The main sunspot cycle changes are (*a*) a variation in the intensity and distribution of streamers, and (*b*) a variation of a 1·8 factor in electron density with a density minimum about a year after sunspot minimum. Temperature variations are only about 15% but are fairly regular. Present knowledge of the source of heating in the corona is too indefinite to allow quantitative estimates of the heat gained by the corona, but the heat lost by conduction and ultraviolet radiation is of the order of 2×10^4 erg cm^{-2} sec^{-1}. The streamers and geomagnetic storms give evidence of a flow of material outward through the corona. This appears to be 1000 times greater than the thermal evaporation and calls for outward forces in the corona that are not at present understood. A.

523.755

4121. The form of the solar corona at the eclipse of 25 February 1952. M. WALDMEIER. *Z. Astrophys.*, **33**, *No.* 4, 286–90 (1954) *In German.*

The ellipticity of the coronal isophotes showing a maximum at about $R = 1{\cdot}8$ is decreasing with increasing distance from the sun's limb up to $R = 4{\cdot}5$. At still larger distances the ellipticity is increasing again. It is suggested that this outermost component of the corona represents the innermost part of the zodiacal light. A.

523.755 : 550.385

4122. Coronal observations and magnetic storms. P. A. WAYMAN. Letter in *Observatory*, **73**, 202–3 (*Oct.*, 1953).

Alternative explanations of the time difference of −3 days between the central meridian passage of a bright coronal region, and the onset of a geomagnetic storm, assumed due to a solar particle stream, are based on the following conceptions—either, that the stream is essentially a narrow jet directed forward against the solar rotation [suggested by Hoyle (1949)]; or (as appears more plausible), that the jet is directed normally to the solar surface, the time of travel from sun to earth being equal to one solar rotation minus 3 days. It is shown that for the latter alternative to operate, the range of particle velocities at ejection, corresponding to a travel-time of 21–23 days, must be 0·5 km/sec only, if an escape velocity of 616 km/sec is assumed. D. R. BARBER

523.77 : 535.417

4123. Interferometric measurements of wave-lengths. I. Development of the method of circular channels and its application at 5080 Å and 6020 Å. M. G. ADAM. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 5, 546–69 (1952).

Collisional shifts are now known to contribute to the differences between solar and laboratory wave-lengths. In view of this, it is in practice essential to

determine the absolute wavelengths in each of the sources independently. Differences reaching as much as 0·010 Å between the accepted earlier measures show that the absolute values of the solar wavelengths, at least have not yet reached the accuracy required for comparisons with theory. A new method of wavelength measurement has been developed, as suggested by Treanor [Abstr. 2145 (1950)], which enables solar and laboratory wavelengths, in any spectral region, to be determined by direct comparison with the primary standard. The methods of observation, measurement and reduction are described in detail. In common with the usual method of "parabolic channels" particular attention has to be paid to the displacement of the centre of the interference pattern, the determination of the focal length of the camera lens, and the correction for phase change, all as functions of wavelength, as well as to departures from the "square law." Measures have so far been made at 5080 and 6020 Å, for solar lines and corresponding lines in the vacuum arc. The "red shift" of the solar lines is 0·0093 Å at 5080 Å, but only 0·0065 Å at 6020 Å. These results cannot be explained as being due to a combination of the relativity shift (0·0107 Å at 5080 Å and 0·0126 Å at 6020 Å), with any reasonable collisional shifts. A.

523.775

4124. On the theory of the spectroheliogram. M. REICHEL. *Z. Astrophys.*, **33**, *No.* 2, 79–114 (1953) *In German.*

The theory of formation of the solar Fraunhofer spectrum is reviewed in the light of recent knowledge concerning the structure of the sun's atmosphere. Consideration is given to the derivation of quantitative estimates of turbulent velocities in the surface layers of the sun, and of the temperature (relative to the undisturbed photosphere) of the facular regions. A comprehensive bibliography is appended.

D. R. BARBER

523.775

4125. On a correlation between the filaments and the distribution in brightness of the corona in the iron line λ 5303. U. BECKER. *Z. Astrophys.*, **33**, *No.* 3, 147–73 (1953) *In German.*

The synoptic charts of solar activity, obtained at the Fraunhofer Institut in Freiburg during the period 1947–1951, are used to investigate the geometrical pattern of filaments and the corona isophotes of the green line Fe XIV λ5303 Å. It is shown that filaments and isophotes are preferably perpendicular, or run parallel to each other. This preferential orientation cannot be caused by systematic properties of the filaments alone, or of the isophotes alone. It is probable that this preponderance of the angles 0° and 90° is due to the symmetry and stability of the systems of coronal currents around the filaments.

A. BEER

523.775

4126. Absolute calibration of the green corona line λ 5303 referred to the centre of the sun. W. KRAUL. *Z. Astrophys.*, **33**, *No.* 3, 174–85 (1953) *In German.*

A photographic-photometric method is used for measuring the intensity of the green corona line, expressed in units of equivalent width in the spectrum of the sun's centre. These intensities serve to calibrate the scale of R. Müller's intensity estimates made at the Wendelstein Observatory. In addition, a method is devised which permits a simple and continuous check on this scale during observation. Comparisons with other stations show satisfactory agreement in the absolute coronal intensities. A. B

523.8 : 53

4127. The oscillation theory of magnetic variable stars. T. G. COWLING. *Monthly Not. Roy. Astr. Soc.*, **112**, *No.* 5, 527–39 (1952).

The paper examines the theory which ascribes the periodic reversal of magnetic field of some stars to internal oscillations. It is shown that, to get sufficiently rapid oscillations, a large internal magnetic field need not be postulated; mechanical forces unaided can always produce a sufficiently rapid oscillation. Indeed, only for a particular class of oscillations do the mechanical forces produce a sufficiently long period: in oscillations of this class the motion is shown to be mainly confined to surface layers. Such oscillations are examined to see if they can explain the periodic reversal of the observed magnetic field. The results so far are negative, but do not cover all the possible oscillations. The problem of the maintenance of the oscillations and other related problems, are briefly discussed.

523

4128. The determination of the position of a radio star. F. G. SMITH. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 5, 497–513 (1952).

A number of new methods of using spaced aerials interferometers to determine the position of a radio star have been devised, and their accuracies are here compared with those of methods which have already been used. The new methods are particularly applicable to the accurate determination of the positions of a small number of the most intense radio stars. The apparent position of a radio star as determined by all such methods will differ from the true position because of various refraction effects in the Earth's atmosphere; the magnitude of these effects at various wavelengths is estimated. It is shown that the results may be confused by the simultaneous reception of radiation from other nearby radio stars, and the resulting error is discussed.

523.8

4129. On some possible mechanisms of radio stars. I. The Crab Nebula. F. D. KAHN. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 5, 514–17 (1952).

It is assumed, first, that the radio-noise emitted by the Crab Nebula is due to the deflection of fast electrons (with a velocity of about 10^{10} cm/s) in fields of force with atomic dimensions. The total energy output necessary for this process is found to be improbably large. It is further shown that it is not possible to explain the observed intensity of radio noise by free-free transitions due to electrons with thermal velocities only. A

523.851

4130. The diameter of the globular star clusters. W. LOHMANN. *Z. Astrophys.*, **32**, *No.* 4, 298–303 (1953) *In German.*

A relation between the diameter, D, of the cluster and its absolute magnitude, M; distance, R, from the

galactic centre; and the interstellar absorption, A, exists in the form:—$\log D = aM + b \log R + cA + d$ where a, b, c and d are coefficients, values for which have been deduced from the observational data of Shapley–Sayer (1935) and Mowbray (1946) for 25 clusters. D. R. BARBER

523.854.3

4131. On the statistics of perigalactic distances. W. LOHMANN. *Z. Astrophys.*, **33**, *No.* 3, 186–93 (1953) *In German.*

An approximation to the gravitational field in the galactic plane is taken in the form $ar/(1 + br^3)$ and the constants a and b are estimated to be $5{\cdot}48 \times 10^{-30}\,\mathrm{sec}^{-2}$ and $0{\cdot}205 \times 10^{-66}\,\mathrm{cm}^{-3}$. Perigalactic distances for stars in the sun's neighbourhood are calculated as functions of velocity and direction, and results are compared with those derived from other approximations to the galactic field. R. A. NEWING

523.872

4132. A spectrophotometric comparison between high- and normal-velocity stars. J. AX. *Z. Astrophys.*, **32**, *No.* 4, 257–72 (1953) *In German.*

Small-dispersion objective prism spectrograms of 13 stars, comprising high and normal radial velocity groups (spectral types F6, GO and G2) were examined in the wavelength range, 3780 Å to 4780 Å, for a significant difference in their spectral characteristics. Apart from a confirmation of previous results for CN- and metallic line-absorptions [Keenan, Morgan and Munch (1948)] no measurable distinguishing features were found for the two velocity groups. D. R. BARBER

523.872

4133. Sodium lines in late-type spectra. P. W. MERRILL AND A. L. LOWEN. Note in *Publ. Astron. Soc. Pacific*, **65**, 280–2 (*Dec.*, 1953).

Microphotometer tracings of the D-lines in 1 KO- and 8 M-type stars, with a solar comparison, are given to illustrate interesting differences in intensity or character of these lines and to stimulate further investigation, particularly in M-, S-, R- and N-type stars. D. L. EDWARDS

523.872 : 535.338

Experimental afterglows with Balmer decrements relevant to astronomical spectra. *See Abstr.* 4333

523.877

4134. Oscillations of a star in its own magnetic field: An illustrative problem. V. C. A. FERRARO AND D. J. MEMORY. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 4, 361–73 (1952).

The free oscillations of a highly idealized star in its own magnetic field are considered for the case when the magnetic field, instead of being assumed to be uniform, after Schwarzschild [Abstr. 1440 (1950)], increases radially inwards from the surface. It is shown that, in Schwarzschild's discussion, the identification of the uniform magnetic field with the value of the star's magnetic field near its centre is incorrect. As a consequence, for a star such as HD 125 248 possessing a magnetic field whose surface value is of the order 7000 gauss, the periods of the lowest modes of (free) vibrations are of the order of two years and not of the order of several days. It is suggested that a variable stellar magnetic field may be explained as due to forced oscillations in a pulsating magnetic star, but that a detailed investigation must take into account gravity variations as well as the increase of magnetic field with depth. A.

523.877

4135. The unsteady accretion problem. K. N. DODD. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 4, 374–81 (1952).

A method is given for examining the behaviour of the Bondi–Hoyle–Lyttleton mechanism of accretion in the unsteady state. The results are given of a numerical investigation carried out on the Manchester University Electronic Computer, to find the rate of accretion by a star after entering a cloud of interstellar material and to examine the effect on the accretion rate of the variation of density at the edge of the cloud. The value obtained for the rate of accretion in a case similar to that considered by Bondi and Hoyle shows satisfactory agreement with their estimate and the results confirm that the more rapid the change of density, the less is the accretion rate, as suggested by Bondi and Hoyle. A.

523.877

4136. Radiative solutions of the stellar equations. R. J. TAYLER. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 4, 387–98 (1952).

Stellar models with energy generation according to the law $\varepsilon \propto pT^{\eta}$ are considered for various opacity laws, and the values of η, for which a convective core is obtained, are determined. It is found that the limiting value of η varies between 1 and 8·5 for the opacity laws considered. These conclusions are compared with those of Cowling, who considered a different law of energy generation. The model of a completely radiative star with $\eta = 3{\cdot}5$ and Kramers' opacity is investigated. The model is compared with the convective model with the same opacity law but different energy generation, and their properties are found to be not widely different. Comparison is also made with radiative models of Eddington and Biermann with other laws of energy generation. A.

523.877

4137. Models for unmixed stars. A. E. ROY. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 5, 484–96 (1952).

A set of point-convective models of a star with a range of discontinuities of molecular weight between core and envelope has been derived using a modification of the Bondi method. These models are used to examine the evolutionary spread of unmixed stars to the right of the H–R diagram. It is found that the radius of an unmixed star could increase by a factor of ten owing to the exhaustion of hydrogen during evolution. A.

523.877

4138. On the theory of white dwarf stars. I. The energy sources of white dwarfs. L. MESTEL. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 6, 583–97 (1952).

Present theories of the origin of white dwarfs are discussed; it is shown that all theories imply that there can be no effective energy sources present in a white dwarf at the time of its birth. The temperature distribution of a white dwarf is then discussed on the

assumption that no energy liberation occurs within the star, and that it radiates at the expense of the thermal energy of the heavy particles present. In the resulting picture, a white dwarf consists of a degenerate core containing the bulk of the mass, surrounded by a thin, non-degenerate envelope. The energy flow in the core is due to the large conductivity of the degenerate electrons, while the high opacity of the outer layer keeps down the luminosity to a low level. Estimates of the ages of observed white dwarfs are given and interpreted. Finally, it is shown that white dwarfs may accrete energy sources and yet continue to cool off, provided the temperature at the time of accretion is not too high; this suggests a possible model for Sirius B. A.

523.877

4139. On the theory of white dwarf stars. II. The accretion of interstellar matter by white dwarfs. L. Mestel. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 6, 598–605 (1952).

The behaviour of a white dwarf subsequent to its accreting substantial quantities of interstellar matter is shown to depend critically on the star's internal temperature at the time of accretion. A cool star merely develops a non-homogeneous structure and continues to cool off, as in the model for Sirius B suggested in Pt I. A hot star changes its form radically; depending on circumstances, it may evolve into a sub-dwarf or possibly a sub-giant state, or it may explode like a gigantic hydrogen bomb and be observed as a type of supernova. A.

523.877

4140. Red shifts in the spectra of celestial bodies. E. Finlay-Freundlich. *Phil. Mag.*, **45**, 303–19 (*March*, 1954).

The red shift of the spectral lines of B-stars belonging to the Orion Nebula group, relative to the lines of the spectrum of the Nebula itself, is shown to be about ten times larger than the red shift which the theory of relativity predicts on the basis of the known values of their masses and radii. A similar discrepancy is found in the case of O-stars. It is suggested that the red shift may be due to a loss of energy in the radiation field of the star. If $\Delta\nu$ is the change of frequency of the line and ν its original frequency, the following formula is proposed. $\Delta\nu/\nu = -A \,.\, T^4 \,.\, l$ when A is a constant, T the temperature of the radiation field and l the length of path traversed through the radiation field. It is shown that this formula represents not only the observations on O- and B-stars, but also on A-stars, the sun, supergiant M-stars, Wolf–Rayet stars and on the so-called cosmological red shift. In addition to the red shift given by this formula the data from the sun and from white dwarfs seem to suggest that there exists an additional gravitational red shift which is, however, only a fraction (about 1/5) of the red shift predicted by the theory of relativity. A.

523.877

4141. On Freundlich's red-shift. D. ter Haar. *Phil. Mag.*, **45**, 320–4 (*March*, 1954).

Freundlich's data (preceding abstract) are analysed and it is shown (i) that the energy loss leading to the observed red shifts is most probably taking place in the stellar atmospheres; (ii) that neither the Compton effect nor photon-photon interaction in the fo considered by Euler and Kockel can account for effect; (iii) that if the red shifts are due to a phot photon interaction effect, the cross-section is at le of the order of 10^{-23} m^2, and if they are due photon-electron interactions the lower limit for cross-section is about 10^{-21} m^2; (iv) that a photo electron interaction is more likely to be the cause the red shift than a photon-photon interaction.

523.8

4142. On a problem in the theory of formation absorption lines. D. W. N. Stibbs. *Monthly N Roy. Astron. Soc.*, **113**, *No.* 4, 493–504 (1953).

The paper gives an exact solution to the probl of determining the intensity of radiation emergi from a semi-infinite plane-parallel atmosphere wh the Planck function $B(\nu, T)$ varies linearly with t optical depth, the ratio of line to continuous abso tion is constant with depth, and when the line scatt ing is partly coherent and partly non-coherent. T non-coherent part of the scattering is taken to proportional to the coefficient of line absorption a to the mean intensity of radiation at the centre of t line, a process which is a simplified form of complet non-coherent scattering. The combination of bo scattering processes in a suitable ratio describes t formation of subordinate lines and, to a certa degree of approximation, resonance lines broaden by collisions. The solution in the general ca involves auxiliary functions which satisfy two simu taneous linear integral equations, but when the no coherent part of the scattering alone is present, t solution only depends on the H-functions, the moments, and the quadrature of a simple integ form.

525.7

4143. A statistical basis for the theory of stell scintillation. S. Chandrasekhar. *Monthly No Roy. Astron. Soc.*, **112**, *No.* 5, 475–83 (1952).

Current theories of stellar scintillation and astr nomical seeing suppose that there is a disturbe region in the atmosphere at a height of about 4 k which corrugates a plane wavefront passing throug it; and that the observed phenomena are to b accounted for in terms of such a corrugated wav front. On the assumption that the disturbed regio is a turbulent layer in which the refractive index, μ is subject to irregular fluctuations, the auto correlation, $\overline{\delta\mu(\mathbf{r}_1)\delta\mu(\mathbf{r}_2)}/\overline{\delta^2\mu}$, of the instantaneou fluctuations in the refractive index at two differen points $\mathbf{r}_1$ and $\mathbf{r}_2$ is introduced; on the further assump tion that the turbulence which prevails is homogeneou and isotropic, the auto-correlation so defined can b a function, $M(r)$ (say), only of the distance r betwee the two points considered. It is then shown how th statistical properties of the corrugated emergent wav front, such as the angular dispersion in the wav normals, can be expressed in terms of $M(r)$. From the known facts concerning astronomical seeing it i concluded that we can satisfactorily account for th observed phenomena by postulating a turbulent laye of a thickness of the order of a hundred metres, micro-scale of turbulence of the order of ten centi metres and a root-mean-square fluctuation i refractive index of the order of 4×10^{-8}. A

PHYSICS 53

53 : 51

4144. Methods of theoretical physics. P. M. MORSE AND H. FESHBACH. *New York, Toronto, London: McGraw-Hill Book Company* (1953). 2 vols: *Part I* (xxii + 997 + xl *pp.*); *Part II* (xviii + 980 *pp.*).

"The portions [of theoretical physics] in which the most noticeable advances have been made in the past twenty years are mostly concerned with fields . . . which are solutions of partial differential equations and specified by boundary conditions. The present treatise concentrates on this general area . . . [and] is primarily concerned with an exposition of the mathematical tools which have been proved most useful. . . ." The authors aim at a comprehensive and self-contained treatment of the relevant mathematical techniques while stressing, at the same time, the physical background.

In Chaps. 1 and 2 the general properties of fields are discussed, and their differential equations in different co-ordinate systems. Topics include flexible string, elastic waves, motion of fluids, diffusion and the Maxwell, Schrödinger, Klein-Gordon, and Dirac equations. Chap. 3 deals with the application of variational principles to fields and includes Hamilton's principle, Lagrange equations, Poisson brackets, action integral. Chap. 4: Functions of a complex variable, including asymptotic series, method of steepest descent, conformal mapping, Fourier, Laplace, Mellin transforms. Chap. 5: Differential equations, separability of the wave equation in three-dimensional co-ordinate systems, properties of solutions and integral representations. Chap. 6: Boundary conditions, eigenfunctions, complete sets, generating functions. Chap. 7: Green's functions, their properties and applications, eigenfunction expansions, abstract vector form. Chap. 8: Classification and general properties of integral equations and their solution, including use of Green's functions, transform methods, Wiener–Hopf method, factorization method. Chap. 9: Perturbation methods, boundary perturbations, scattering and diffraction problems, iteration and variational methods.

The remainder of the book deals with detailed applications of the techniques developed in the preceding chapters. Chap. 10: Solutions of the Laplace and Poisson equations in two and three dimensions. Chap. 11: Waves in one, two and three dimensions, including application of integral and variational techniques. Chap. 12: Diffusion problems and solutions of the Schrödinger equation. Chap. 13: Solutions of vector wave equations for different co-ordinate systems and boundary conditions. Formulae, properties of functions, and methods are summarized at the end of each chapter, where short bibliographies and collections of problems are also given. Numerical tables are provided at the end of Part II, including trigonometrical, hyperbolic, spherical harmonic, Legendre (cylindrical, spherical, hyperbolic), Bessel, periodic Mathieu functions. G. FIELD

53.08 : 537 : 538 : 621.316.721/.722

4145. Stabilization problems in physics. P. GOUDAL. *Cahiers de Phys., No.* 45, 40–55 (*Sept.*, 1953) *In French.*

A critical review of various methods of stabilizing voltages, currents and magnetic fields, which have been described by various investigators, together with some results obtained by the author in tests carried out on many types of stabilizer. These include an arrangement of two stabilovolt stages in cascade, mains-voltage regulators, without frequency compensation, of both Westinghouse and MCB types, and an MCB regulator with frequency compensation. The importance is stressed of taking account of the considerable variations of valve operation due to changes of heater voltage. 15 references to original papers and books are given. A. WILKINSON

53.087.6

4146. A logarithmic chart drive. P. H. DAWSON, F. G. HAYNES AND M. B. COYLE. *J. sci. Instrum.*, **31**, 97 (*March*, 1954).

A mechanism is described which can be used to produce a variable speed drive for a recorder chart. In a particular application to the recording of the isothermal transformation of a steel specimen, the chart travel is proportional to the logarithm of time. A.

FUNDAMENTALS 530.1

530.1

4147. The concept of order. I. The space-time structure. E. W. BASTIN AND C. W. KILMISTER. *Proc. Cambridge Phil. Soc.*, **50**, 278–86 (*Feb.*, 1954).

Even if ideas of measurement did not exist, a great deal of the simple mechanical and electromagnetic structure of the physical world could be understood. To see how this can be so, the orthodox ideas of the relationship of mathematics to physics are inadequate. In this paper a development of this fundamental non-metrical physics is made to depend on a different view of this relationship. A.

530.12

4148. Dirac's electrodynamics and Einstein's unified field theory. G. STEPHENSON. Letter in *Nuovo Cimento*, **10**, 1595–6 (*Nov.*, 1953).

Einstein's 1950 theory is modified by requiring that the electromagnetic field be derivable from a 4-potential A_m and by replacing the condition $\Gamma_m = \Gamma^s_{ms} = 0$ by $\Gamma_m\Gamma^m =$ constant. If the Γ_m are identified with A_m, it is shown that the theory gives a Riemannian generalization of Dirac's non-gauge invariant electrodynamics. R. A. NEWING

530.12

4149. Certain consequences of the existence of the tensor g in the relativistic affine field. S. N. BOSE. *J. Phys. Radium*, **14**, 645–7 (*Dec.*, 1953) *In French.*

Integrability conditions are discussed and it is concluded that conditions imposed for non-symmetric $\Gamma^{\mu}_{\alpha\beta}$ are much more restrictive than for the symmetric case. R. A. NEWING

530.12

4150. Static magnetic fields in general relativity. W. B. BONNOR. *Proc. Phys. Soc.* [*London*] *A*, **67**, 225–32 (*March*, 1954).

A theorem is proved which enables a class of known electrostatic solutions of the field equations to be adapted to the magnetostatic case. Exact solutions referring to a uniform magnetic field and to a magnetic dipole are given. The solution for a circular loop of wire carrying a steady current is considered, and it is shown that if the mass of the wire be neglected, both the magnetic and gravitational fields at great distances are equivalent to those of a magnetic dipole. The paper concludes with a short discussion of the significance of the solutions presented here, and in an earlier paper [Abstr. 2927 (1953)] for relativistic electromagnetic theory. A.

530.12

4151. The application of the Whitehead theory of relativity to non-static, spherically symmetrical systems. C. B. RAYNER. *Proc. Roy. Soc. A*, **222**, 509–26 (*March* 23, 1954).

Synge [Abstr. 2409 (1952)] has reformulated in current standard notation the basic principles of the theory of relativity of A. N. Whitehead and investigated the gravitational properties of a spherically symmetrical static distribution of matter. He applied this theory to the solar field and verified the result previously indicated by Whitehead (1922) that the theory is in good agreement with the local tests satisfied by Einstein's general theory of relativity. The present paper extends the theory of Whitehead to non-static systems whose velocity and density distributions possess complete spherical symmetry about a spatial origin in a Galilean frame of reference. In particular, a uniformly expanding homogeneous world-model is constructed which differs significantly both from Milne's model and that of special relativity. The motion of free particles and photons in this model is investigated and a formula for the law of red shifts is derived. A.

530.12 : 530.145

4152. Relativistic dynamics of *n* points and classical statics of *n* strings. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris*] **237**, 1395–7 (*Nov.* 30, 1953) *In French.*

Relativistic equations of motion of a single particle are analogous to the equations of equilibrium for a string with the correspondence: world line → string, momentum 4-vector → tension, world force → line density of external force on string, the string being flexible only for particles without spin. The Wheeler–Feynman direct interparticle action for n point charges corresponds to interactions between the elements of n strings. R. A. NEWING

530.12 : 531.18

4153. On the pseudo-paradoxes of the restricted theory of relativity. R. DUGAS. *C.R. Acad. Sci.* [*Paris*] **238**, 49–50 (*Jan.* 4, 1954) *In French.*

An observer S', moving with velocity V relative to S, meets S'' moving with velocity $-V$ relative to S, clocks being synchronized at coincidence. It is shown that the difference between the clocks of S and S'' when S'' arrives at S is the same when calcula relative to the frame S' as for the frame S.

R. A. NEW

530.12 : 53

4154. Rotation and magnetism in the world-mod of kinematic relativity. P. J. D. GETHING. *Mont Not. Roy. Astron. Soc.*, **112**, *No.* 6, 578–82 (1952).

Milne's theoretical relation between rotation a magnetism in the idealized world-models of Kinema Relativity is examined. It is shown from conside tions of symmetry that the rotation of a body loca in a "fluid" of uniform density should produce magnetic field of zero magnitude; if the mass d tribution is asymmetrical with respect to the rotat body a non-zero field should be produced, altho there appears to be no simple proportionality betwe the field intensity and the angular momentum of t body. These results do not appear to support Miln claim to have established a theoretical basis for simple formula of the Blackett type.

530.145 : 51

4155. A theory of physical propositions. GRAWERT. *Z. Phys.*, **136**, *No.* 2, 206–20 (1953) *German.*

A mathematical theory which introduces prob bility. It is developed on the basis of a set of post lates, the first of which is this: the set of propositio over a given physical system form a complement complete lattice. The probability of a proposition introduced in the second postulate, as a functi satisfying certain rules. Various theorems a obtained and their significance for quantum theory explained. L. S. GODDAR

530.1

4156. On the variational principles in quantu mechanics. G. RIDEAU. *C.R. Acad. Sci.* [*Paris*] **23** 1646–8 (*Dec.* 21, 1953) *In French.*

A general method for finding variational principl for collision theory shows the existence of an i definite number of such principles. If the variation principle is to be independent of the normalization the trial function the same method gives a uniqu principle. F. ANSBACH

530.145 : 532.51 : 534.01 : 539.

4157. The application of Fourier transforms physical problems. W. H. WATSON. *Trans Roy. So Canada III*, **47**, 37–46 (*June*, 1953).

A lecture, in which various classical problems ar properties are reviewed. A list of topics is given i which Fourier transforms have played an importa part; these include theory of vibrations, diffusio elasticity, hydrodynamics, wave equations. Tw problems are discussed in some detail, (1) the theor of the slowing-down and diffusion of neutrons, (2) th decay of resonance radiation by spontaneous emissio The use of the Schwarz theory of distributions i physical problems is discussed [see Abstr. 293 (1953)]. L. S. GODDAR

530.14

4158. Classical field theory [Klassische Feldtheorie] D. IVANENKO AND A. SOKOLOW. *Berlin: Akademie Verlag* (1953) xi + 347 *pp. In German.*

This book comprises a unified classical treatment o problems arising from the usual electromagneti

heory, such as electrostatic potential problems and lectromagnetic wave theory, and of problems of uantum electrodynamics and meson theory which an be discussed from a classical point of view. The nethods developed in the latter theories are utilized o treat the former problems of electromagnetic heory. To begin with, a treatment of the δ-function s given, and the Green's function is developed in this ormalism. By means of the Green's function, elec- romagnetic problems described by Laplace's, Pois- on's and D'Alembert's equations are solved. The reatment is analogous to that used in modern uantum field theory, and consequently, the static neson equation and Klein–Gordon equation are dis- ussed in the same section. Classical electrodynamics s introduced in a relativistic form, and transforma- ion properties of the fields are discussed. Side by side with the usual problems involving the Maxwell equations, Cherenkov radiation is treated. Non- linear theories, theories with higher derivatives, and various modifications of the usual theory needed to obtain a finite electron mass are presented. The scattering of light by electrons and radiation from accelerated electrons is discussed. A comprehensive treatment of classical meson theory is given, in its scalar, pseudoscalar, vector and pseudovector variants, as well as scattering of the various mesons. The generalization of classical to quantum theory is briefly described in an appendix on the development, of the theory of the vacuum. The Lamb shift, anomalous magnetic moment of the electron, super- many-time formalism and regularization are briefly mentioned. G. E. BROWN

530.145

4159. Field theories and the theory of the elementary particles. H. C. CORBEN. *Nuovo Cimento*, **10**, *Suppl. No.* 3, 260–4 (1953) *In Italian.*

530.145

4160. On regularization by means of analytic continuation. E. KARLSON. *Ark. Fys.*, **7**, *Paper* 21, 221–37 (1953).

A modified form of the method suggested by Källén can also be applied to the e^4-approximation of the vacuum polarization. The result is that only gauge invariant terms will appear. All computations are carried out on convergent expressions. A.

530.145

4161. On the concept of field quantization. F. A. KAEMPFFER. *Canad. J. Phys.*, **32**, 259–63 (*March*, 1954).

Attempts by Takabayasi and Kaempffer at an entirely different method of field quantization, starting from the hydrodynamic formulation of classical field theories rather than from their formulation in terms of wave equations, are examined in the light of Ziman's recent successful approach towards the quantum hydrodynamical problem. It is pointed out that the energetic impossibility of a roton spectrum in an ideal continuum fluid, as shown by Ziman, makes it necessary to introduce into the theory a fundamental length, which acts as high-frequency cut-off, and which may be interpreted as representing a substructure of the medium in which elementary particles may appear as excitations of the motion. Takabayasi's generalized hydrodynamic formulation of the non-relativistic Schrödinger equation is treated as an example, and it is shown that the fundamental length must be of the order h/mc, if the particle corresponding to the single roton excitation of the Takabayasi field is to have the mass m. A.

530.145 : 535.338.332 : 539.153

4162. Elementary particles and the Lamb–Retherford line shift. L. L. FOLDY. *Phys. Rev.*, **93**, 880–1 (*Feb.* 15, 1954).

According to the principles of contemporary quantum electrodynamics, the existence of a charged particle field of any kind results in a vacuum polarization contribution to the Lamb–Retherford line shift of an amount proportional to the square of the charge and inversely proportional to the square of the mass of the field particle. On the basis of the present agreement between theory and experiment with respect to the line shift in hydrogen, one may conclude that no singly charged particles of spin $\frac{1}{2}$ with mass less than four electron masses, other than the electron and positron, can exist without spoiling this agreement. Similar reasoning argues against the existence of singly charged particles of spin 0 with mass less than twice the electron mass. For doubly charged particles these limits are quadrupled. The assumptions involved in these conclusions as well as some experimental evidence are briefly discussed. A.

530.145

4163. On gauge invariance in electrodynamics and the self-energy problem of the photon. O. HARA AND H. OKONOGI. *Progr. theor. Phys.*, **10**, 191–8 (*Aug.*, 1953).

The physical meaning implied in the gauge invariance of electrodynamics is analysed using the Hamiltonian formalism. The self-energy of the photon is calculated as a limit of diminishing to zero the rest mass of the self-energy of a neutral vector quantum with small rest mass. The inevitability of introducing the method of renormalizing the light velocity as proposed in the authors' previous paper [Abstr. 58 (1954)] is concluded from these results. A.

530.145

4164. Reisz potential and the elimination of divergences from quantum electrodynamics. II. L. S. KOTHARI. *Proc. Phys. Soc.* [*London*] *A*, **67**, 201–5 (*March*, 1954).

For Pt I, see Abstr. 2011 (1954). The solution of the Dirac equation in interaction representation and the Feynman function S_F are generalized in the β-plane, β being a parameter characteristic of the Reisz potential. It is then shown that by using the generalized function $\mathcal{S}_F^{\beta}(x)$ instead of S_F, divergence arising from the lowest order photon self-energy graph can be eliminated, though the result obtained is not gauge invariant and contains the Wentzel term. A.

530.145 : 539.153

4165. Volume effect in the isotope shift in hydrogen and deuterium. D. D. IVANENKO AND N. N. KOLESNIKOV. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 47–50 (1953) *In Russian.* English translation, *U.S. National Sci. Found., NSF-tr-79.*

From the proton wave function in the deuteron (square well potential) the correction to the Coulomb

field is computed and found to produce a shift in the electronic terms of $-0{\cdot}775$ Mc/s. However, the proton distribution used is not self-consistent, and, while correcting for this affects the volume effect only slightly, it brings an appreciable contribution to the main electromagnetic effect. The final value for the isotope shift is found to be $0{\cdot}44$ Mc/s. This value would be increased by the use of a Yukawa potential.

L. PINCHERLE

530.145

4166. Theory of the interactions with higher derivatives and its application to the non-local interaction. Y. KATAYAMA. *Progr. theor. Phys.*, **10**, 31–56 (*July*, 1953).

Extending Yang–Feldman's method to the system with the interaction Lagrangian with higher derivatives, the author obtains the Hamiltonian in the interaction representation. He then shows that the Hamiltonian thus obtained is that given by the usual Heisenberg–Pauli method using canonical conjugates differing from the independent variables of the variation, i.e. if such canonical variables are taken the system is reduced to the familiar case without higher time derivatives. This theory can be applied to non-local interaction straightforwardly and then the differences between non-local interaction and non-localized action can be explained. Also the possibility of the removal of the divergences by introducing the non-localities is discussed. A.

530.145

4167. On the constants of motion for the case of non-localized interactions. Y. ÔNO. *Progr. theor. Phys.*, **10**, 125–36 (*Aug.*, 1953).

By generalizing the method formerly developed by the author, the energy-momentum tensor is obtained also for the case of non-localized interactions. It is found that the interaction part of this tensor is not given simply by $-L'\delta_{\mu\nu}$ as due to Kristensen–Møller and Bloch, and that the total tensor satisfies the equation of continuity as a consequence of the equations of motion. As the result of the space integration of the μ^4 component of the tensor, a general and simple expression of the energy-momentum 4-vector is derived in terms of δ functions and sign functions of the time. This vector turns out to be the constant of motion owing to the continuity equation. The same is true of the case of current density and total charge. Thus, it may be asserted, contrary to the opinion of Kristensen–Møller and Bloch, that it is always possible to construct not only the constants of collision but also the constants of motion when the invariant Lagrangian is given. The problem is now to consider the physical significance of the expressions and how to perform the quantization upon Heisenberg representation. A.

530.145

4168. Towards a renormalized single-time Bethe–Salpeter equation. K. SYMANZIK. *Nuovo Cimento*, **11**, 88–91 (*Jan.*, 1954) *In German.*

The reduction of the Bethe–Salpeter equation, in which all of the infinite parts have been dropped, to a single-time theory is demonstrated graphically.

G. E. BROWN

530.

4169. Experimental consequences of the electr neutrino theory. B. JOUVET. *C.R. Acad. Sci.* [*Pa* **238**, 55–7 (*Jan.* 4, 1954) *In French.*

The possibility of pair creation by neutrinos a of spin-1, zero-mass "deutrinos" consisting of neutrinos is mentioned. W. J. SWIATE

530.

4170. On the coupling of a Dirac field with bos of spin 1. F. CAP. *Acta phys. Austriaca*, **8**, *No.* 191–7 (1953) *In German.*

Conservation theorems are deduced for the ten densities derivable from Dirac spinors. With th aid it is shown that the vector meson theory does n give a Bartlett force in the static approximation. T pseudovector theory is also investigated and relation to electrodynamics. F. ANSBACH

530.1

4171. Charged elementary particles with spin 1. DONNERT. *Z. Phys.*, **136**, *No.* 3, 331–43 (1953) *German.*

Earlier results of calculations of the scattering in static Coulomb field are discussed. The wa equations are then written in tensor form and spinor form and then a transition is made to secon order equations. The adjoined wave equation, t current density vector and the Lagrange function a given and these are used in a calculation of the elas scattering of fast elementary particles of spin 1 in static central electric field. L. S. GODDA

530.1

4172. The relativistic theory of particles wi maximum spin 1. I. ÚLEHLA. *Czech. J. Phys.*, *No.* 3–4, 121–6 (1952).

Deals with the structure of linear relativistic wa equations for particles with maximum spin 1 and wi non-zero rest mass. It can be proved that the on permissible equations for these particles are the know Dirac equations for the electron and the equations f scalar and vector (pseudoscalar and pseudovecto meson fields.

530.14

4173. The theory of the structure of elementa particles. O. HARA AND T. MARUMORI. Letter *Progr. theor. Phys.*, **9**, 559–60 (*May*, 1953).

A four-dimensional rotation operator is defined f the internal co-ordinate which appears in Yukawa non-local field. The square of this operator related to the spin operator and a mass operato The spectrum of mass eigenvalues is given.

G. E. BROW

530.14

4174. Covariant Fourier integrals and resolution o the Cauchy problem for bare particles of spin ½ and 1 O. COSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris* **237**, 1495–7 (*Dec.* 9, 1953) *In French.*

The bare-particle propagators in the γ- and β matrix formalisms respectively are obtained. G. FIEL

530.14

4175. Introduction to an electron-neutrino theory o the photon. B. JOUVET. *C.R. Acad. Sci.* [*Paris*] **237** 1642–4 (*Dec.* 21, 1953) *In French.*

Demonstrates the possibility of interpreting a

photon in terms of interacting electron and neutrino fields. The result is independent of the coupling constant between these fields, electric charge is introduced by the regularization constant, and the zero mass of the photon is a consequence of gauge invariance. G. FIELD

530.145

4176. On the determination of the solutions of the wave equation of a particle of spin $\hbar/2$ in interaction with a radial pseudoscalar potential. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **237,** 1648–50 (*Dec.* 21, 1953) *In French.*

An exact solution of the Dirac equation for a particle in a pseudoscalar potential $V = Cr$. P. T. MATTHEWS

530.145

4177. On Corben's formulation of the Dirac equation. O. BERGMANN AND N. BAKER. *Nuovo Cimento,* **11,** 203–4 (*Feb.*, 1954).

It is pointed out that, although Corben's formulation is connected with the customary Dirac equation by a Foldy transformation, the equivalence does not hold for all types of coupling of charged particles with other fields. W. A. HEPNER

530.145

4178. Scattering problem in the intermediate-coupling theory. I. Z. MAKI, M. SATO AND S. TOMONAGA. *Progr. theor. Phys.,* **9,** 607–32 (*June,* 1953).

The intermediate coupling theory is generalized so as to include dynamical problems such as meson-nucleon collisions. The underlying physical picture, as well as the results obtained, resembles in many respects the dispersion theoretical treatment of nuclear processes. Relations of the method with other approximation methods are investigated. A.

530.145

4179. On the scattering of charged particles by nuclei. E. CLEMENTEL AND A. COEN. Letter in *Nuovo Cimento,* **10,** 988–90 (*July,* 1953) *In Italian.*

The summation in the formula for the differential cross-section may be carried out for non-charged particles and for a completely absorbing nucleus leading to the Bethe–Placzek formula. It is shown that it may be carried out also in the case of charged particles, again for a completely absorbing nucleus, taking into account also the small-angle deflections due to the Coulomb field. L. PINCHERLE

530.145

4180. On the equivalence of the particle formalism and the wave formalism of meson. II. Case of interacting meson and nucleon fields. Z. TOKUOKA. *Progr. theor. Phys.,* **10,** 137–57 (*Aug.*, 1953).

For Pt I, see Abstr. 80 (1954). The β-matrix formalism is applied to the interaction of the charged meson with the nucleon. Harish-Chandra's Γ-formalism is used for introducing the invariant coupling terms, and the scattering matrix S is constructed covariantly by Umezawa–Takahashi's method in order to avoid the troublesome "surface terms." This S-matrix contains a normal independent direct coupling of nucleons besides the usual meson exchange couplings. It is shown that this additional coupling is due to the direct coupling included implicitly in the Lagrangian, and that the possibility, stated by Klein, of cancelling it by the corresponding term appearing in the whole interaction Hamiltonian is lost. The neutral and the charge-symmetrical meson are also discussed briefly. A.

530.145

4181. On the effects of excited states of nucleons upon static nuclear potential in symmetrical pseudoscalar meson theory. I. Derivation of nuclear potential and qualitative conclusions. T. MATSUMOTO, T. HAMADA AND M. SUGAWARA. *Progr. theor. Phys.,* **10,** 199–226 (*Aug.*, 1953).

The effects of excited states of nucleons upon static nuclear potential in symmetrical pseudoscalar meson theory are investigated. An additional interaction Hamiltonian is introduced, according to which a nucleon can make a transition from its ground states to the excited one of both spin and isotopic spin $\frac{3}{2}$, or vice versa. The fourth-order perturbation contribution of this Hamiltonian is calculated in the non-relativistic and static approximations for nucleons. The effects of excited states prove to be very large. The derived nuclear potential contains generally a very strong attractive central force and a very small tensor force of various signs, both of which have very high singularities at the origin. The most interesting feature is that the effects are much larger for charge triplet states than for charge singlet states. The derived nuclear potentials are summarized in the final section with five interesting qualitative conclusions. A.

530.145

4182. Nonlinear pseudoscalar meson theory. F. CAP. Letter in *Nuovo Cimento,* **10,** 1347–8 (*Sept.*, 1953) *In German.* Also in *Progr. theor. Phys.,* **10,** 235–6 (*Aug.*, 1953).

A formulation of the meson field equations analogous to that of Born's non-linear electrodynamics is suggested. G. FIELD

530.145

4183. Second-order processes of the Fermi interaction. P. BUDINI. *Nuovo Cimento,* **10,** 1299–1310 (*Sept.*, 1953) *In Italian.*

The scattering of two Fermi particles is studied as a second-order process of the interaction of spinor fields. A non-localized interaction [Abstr. 3110 (1954)] is introduced to eliminate divergencies. By suitable choice of the form factor it is possible to obtain matrix elements characteristic of both short-range and long-range interactions. As an example the elastic scattering cross-section is worked out between an electron and a neutrino. L. PINCHERLE

530.145

4184. Fourth-order processes of the Fermi interaction. P. BUDINI. Letter in *Nuovo Cimento,* **10,** 1486–8 (*Oct.*, 1953) *In Italian.*

Matrix elements of fourth-order processes between Fermi–Dirac particles may be made convergent by introducing the non-localized interaction described in the preceding abstract. There is a discussion of the possibility of explaining gravitational phenomena between Fermi particles by means of these processes (the gravitational quantum has spin 2). L. PINCHERLE

530.145

4185. Bound particles and scattering problems in quantum field theory. E. FREESE. *Z. Naturforsch.*, **8a**, 776–90 (*Dec.*, 1953) *In German.*

Using the Heisenberg representation, all physical phenomena, including bound-state problems, can be described with the help of certain "wavefunctions" satisfying differential or integral equations. The connection with Dyson's *S*-matrix is considered.

W. A. HEPNER

530.145

4186. Three-body scattering problems. S. BOROWITZ AND B. FRIEDMAN. Letter in *Phys. Rev.*, **93**, 251–2 (*Jan.* 1, 1954).

Reply to Dalgarno's remarks [Abstr. 6478 (1953)] on a paper by the authors. W. A. HEPNER

530.145

4187. The angular correlation of mesons produced in inelastic meson-nucleon collisions. J. S. KOVACS. Letter in *Phys. Rev.*, **93**, 252 (*Jan.* 1, 1954).

In the case of strong meson-nucleon coupling mesons would be "evaporated" from the nucleon. For strong meson-meson coupling mesons would be directly knocked out. The angular correlations between 2 emerging (scalar) mesons are given in the two cases. W. J. SWIATECKI

530.145

4188. On Milne's problem for a Rayleigh single scattering law $[1 + \cos^2 \theta]$. R. MERTENS. *C.R. Acad. Sci.* [*Paris*] **238**, 53–5 (*Jan.* 4, 1954) *In French.*

Using the author's results [Abstr. 6475–6 (1953)] the 3rd-order solution is given and compared with the exact solution of Chandrasekhar. W. J. SWIATECKI

530.145

4189. On the elastic scattering of a particle by a complex system. P. N. ROUSSOPOULOS. *C.R. Acad. Sci.* [*Paris*] **238**, 213–15 (*Jan.* 11, 1954) *In French.*

Starting from the integral equation of Lippmann and Schwinger [Abstr. 8498 (1950)], it is shown that the problem may be reduced to that of scattering by a (complex) potential which depends only upon the position of the incident particle. E. H. SONDHEIMER

530.145

4190. Radiative effects in meson-nucleon scattering. S. DESER. *Phys. Rev.*, **93**, 612–14 (*Feb.* 1, 1954).

An integral equation is derived which sums the contributions of a certain (infinite) set of radiative corrections to lowest-order meson-nucleon scattering. This equation for the *S*-matrix is examined and an approximate treatment given. The resulting scattering amplitude is exhibited in the Thomson and high-energy limits. A.

530.145

4191. On the classical theory of particles interacting with electromagnetic and mesonic fields. I. P. HAVAS. *Phys. Rev.*, **93**, 882–8 (*Feb.* 15, 1954).

The classical equations of motion of particles which are simple poles of both the electromagnetic and the neutral (scalar or vector) mesonic field are formulated both for field theory and for the theory of action at a distance. These equations are used to discuss the field contributions to the mass of the particles, the scattering of electromagnetic radiation, photome production, mesonic production of electromagn radiation and the electromagnetic corrections meson scattering.

530.

4192. Nucleon-nucleus collisions at relativistic en gies. G. COCCONI. *Phys. Rev.*, **93**, 1107–8 (*Marc* 1954).

The Fermi theory of multiple meson productio utilized in the interpretation of high-energy collisi between nucleons and complex nuclei. A relat between the total number of relativistic partic produced, their angular spread and the number nucleons involved in the collision is found to satisfied by all the cases of relativistic showers p lished thus far.

530.

4193. Bound state corrections in two-body syste T. FULTON AND R. KARPLUS. *Phys. Rev.*, **93**, 11 118 (*March* 1, 1954).

Available expressions for two-body equati contain an interaction kernel which treats particles intermediate states as free. In situations where binding is important, such as the calculation of l energy electrodynamic corrections, a more accur treatment is necessary. A satisfactory formalism developed for systems in which an instantanec interaction is responsible for the binding. T procedure may then be used to evaluate the effects small retarded perturbations. It consists of summi those binding interactions which occur during retarded perturbations and which never should ha been expanded as "small" effects. The result expressed in terms of the two-body Green's functi of the instantaneously interacting system. T function occurs to describe the propagation of t two particles in the intermediate state. The relat time co-ordinate does not appear explicitly in t formulae. The method is applied to calculate t hyperfine structure of positronium. The infrar divergences which occurred in a previous investigati of this effect are eliminated by the new approach.

530.1

4194. Modified propagators in field theory (w application to the anomalous magnetic moment of t nucleon). G. FELDMAN. *Proc. Roy. Soc. A*, 22 112–29 (*April* 7, 1954).

Many attempts have been made to improve up the perturbation expansion in meson-field theori one such attempt being the introduction of modifi propagators S'_F and Δ'_F. It is shown in this pap that the introduction of these new propagators (at least in the form that has been proposed) creat new infinities which cannot be removed by renorma zation. These new infinities are due to new compl poles of the modified propagators. A tentati prescription is put forth to get over these new dif culties, but it is still intimately connected with t perturbation expansion. Unfortunately, the prescri tion does not give an unambiguous answer. A pa ticular S'_F is used in the calculation of the anomalo magnetic moment of the nucleon. The resul obtained are no better than those of other worker However, there are many reasons why this may

e case. It is also shown that the subseries which ises in this case leads, at best, to an asymptotic pansion in the coupling constant. The nature of e singularity at zero coupling is found. A.

530.145

.95. On the many-body problem in quantum echanics. A. F. TSANDER. *Dokl. Akad. Nauk SSR*, **90**, *No.* 5, 761–4 (1953) *In Russian.* English anslation, *U.S. National Sci. Found. NSF-tr*-154.

Symmetry properties of a wavefunction for Z rotons and A–Z neutrons are discussed. General atures of the kinetic and potential energies are entioned. G. E. BROWN

530.145

196. On the wave-particle duality. M. RENNINGER. *. Phys.*, **136**, *No.* 3, 251–61 (1953) *In German.*

A "thought experiment" (an intuitive experiment ot resting on any formal or mathematical analysis) s described in which both the wave and particle haracter of a photon are manifested in one and the ame (interference) experiment. In an appendix it is hown that it is possible to construct this interference xperiment in its practical details. G. E. BROWN

530.145

4197. Miscellanea in elementary quantum mechanics. I. K. HUSIMI. *Progr. theor. Phys.*, **9**, 381–402 (*April*, 1953).

For Pt I, see Abstr. 2039 (1954). It is a rather curious fact that the exact quantal treatment of forced oscillation has only recently been discovered to be feasible. There may be general arguments which make the possibility of such a treatment very convincing, but the author finds the ground for it in an elementary observation that the wave equation of forced harmonic oscillation, including the case of subharmonic resonance, admits a solution of Gaussian type, i.e. of the form: an exponential of a quadratic. On this basis the complete solution and the related problems are analysed here. A.

530.145

4198. Miscellanea in elementary quantum mechanics. III. Uncertainty relations and ground states. K. HUSIMI AND M. ÔTUKA. *Progr. theor. Phys.*, **10**, 173–90 (*Aug.*, 1953).

On the ground that there exists an intimate correlation between the uncertainty relation and the ground state of a quantum-mechanical system, variants of the usual uncertainty relation and a method of determining the ground states for a number of systems are presented. Strangely enough, the arguments may be applied also to excited states. A.

530.145

4199. On the convergence of the perturbation method in the quantum field theory. R. UTIYAMA. *Progr. theor. Phys.*, **9**, 593–606 (*June*, 1953).

The convergence of the Green-functions of one-nucleon and one-meson problems is investigated. In order to get finite expressions for these Green-functions, the vertex function Γ is defined. By virtue of this definition the number of graphs of the proper vertex-type of the nth order in g increases so slowly that the majorant series of the Green-function can be made to converge. A.

530.145

4200. On the impossibility of decomposing a wave-function of an assembly of fermions M_i into a product of individual wavefunctions $\psi_i(M_i)$. G. BODIOU. *C.R. Acad. Sci.* [*Paris*] **237**, 1493–5 (*Dec.* 9, 1953) *In French.*

It is shown that, even for different $\psi_i(M_i)$, the general requirement of antisymmetry is incompatible with a simple product decomposition of the wave-function ψ. G. FIELD

530.145

4201. Quantum distributions in differential space for wave functions dependent on spin. N. WIENER AND A. SIEGEL. *C.R. Acad. Sci.* [*Paris*] **237**, 1640–2 (*Dec.* 21, 1953) *In French.*

It is shown that the new representation of wave-functions and interpretation of probability [Abstr. 98 (1954)] cover spin dependence. F. ANSBACHER

530.145

4202. Derivation of the quantum-mechanical wave equation of the many-particle system from a classical model. W. WEIZEL. *Z. Phys.*, **136**, *No.* 5, 582–604 (1954) *In German.*

The wave equation of this system can be resolved into two real equations which, by assuming that the particles are undergoing random external perturbations of their classical motion, can be interpreted as the continuity equation and the equation of momentum balance. Conversely the wave equation can be reconstructed from these two equations if the velocity in configuration space is irrotational, a condition which is shown to hold always if it holds at any instant. P. M. DAVIDSON

530.145

4203. Particle introduced into a given field: definition of eigenfunctions and eigenvalues by means of 4-fold integrals. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris*] **238**, 50–3 (*Jan.* 4, 1954) *In French.*

An imaginary term added to the proper mass introduces a non-zero divergence in the 4-current, and plays the role of a source for the given field. F. ANSBACHER

530.145

4204. Superquantification of our recent scheme. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris*] **238**, 211–13 (*Jan.* 18, 1954) *In French.*

An interpretation is proposed of the invariant state vector in the Heisenberg representation. Remarks on the case of a field admitting of one or more translational invariance (preceding abstract). A.

530.145

4205. The quantum-mechanical partition function. G. V. CHESTER. *Phys. Rev.*, **93**, 606–11 (*Feb.* 1, 1954).

A simple method is demonstrated of expanding the quantum-mechanical partition function in powers of the interaction potential between the particles of the system. The result is valid for all types of statistics and for all types of interaction, provided the interaction potential is nonsingular. The general term is expressed, in terms of known quantities, in a compact form. It is shown that the series must be considerably modified for the case in which the potential is singular. The convergence of the series is discussed briefly. A.

530.145 : 530.162

4206. Quantum statistics for particles with a special interaction. G. HEBER. Note in *Z. Naturforsch.*, **8a**, 827 (*Dec.*, 1953) *In German.*

Qualitative considerations on a molecule-forming interaction. W. A. HEPNER

530.162

4207. Notes on Fermi and Bose statistics. M. TODA and F. TAKANO. *J. Phys. Soc. Japan*, **9**, 14–18 (*Jan.–Feb.*, 1954).

By expanding the grand partition function, the expression for the partition function of two-dimensional free particles is obtained, and seen to be of the same form as that of one-dimensional harmonic oscillators. For such systems it is shown that the difference in statistics does not appear in thermal behaviour. When the energy levels of the particles are modified as $\varepsilon_{n_1, n_2} = \Delta + b(n_1^2 + n_2^2)$, $\Delta > 0$, the Bose condensation occurs and, if $\Delta = 2b$, the condensation temperature qualitatively agrees with that of Osborne. The specific heat of free bosons in a narrow box is calculated as the function of temperature, its width d being taken 7·1 Å and 14·2 Å. The results show that the maximum of the specific heat occurs at higher temperatures than that of the case $d = \infty$, and its height becomes less. The weak excitation of a Fermi system can be treated as excitons which obey Bose statistics. And it can be shown, by a method analogous to that of Ward and Wilks and Dingle, that the sound wave in a Fermi gas should be considered as second sound, or the propagation of a fluctuation in exciton distribution. Its propagation velocity is shown to become $p_0/\sqrt{3}m$, where p_0 is the momentum at the Fermi surface. A.

530.162

4208. Statistics of a population with creation and recombination dependent on existing numbers. D. A. BELL. *Proc. Phys. Soc.* [*London*] *B*, **67**, 227–31 (*March*, 1954).

Studies of fluctuations in gas density are commonly based on a Poisson distribution of probability of the number present. It is pointed out that this applies *only* to a population in which the rate of creation is constant and the rate of loss proportional to the first power of the number present. Populations liable to loss by recombination are likely to have a rate of loss proportional to the square of the number present; and the distribution function is then related either to a Bessel function or to a Laguerre polynomial, according as the rate of creation is either constant or dependent on the complement of the number already present. The variance of the Bessel type of distribution is half that of a corresponding Poisson distribution. A.

530.162 : 519.2

4209. On the application of the concept of the characteristic function to the study of certain problems in statistical mechanics. A. BLANC-LAPIERRE. *C.R. Acad. Sci.* [*Paris*] **237**, 1635–7 (*Dec.* 21, 1953) *In French.*

The methods of probability theory are used to rederive certain results due to R. H. Fowler.

E. H. SONDHEIMER

530.162 : 53

4210. Statistical mechanics of general Brown motions underlying irreversible processes. YAMAMOTO. *Progr. theor. Phys.*, **10**, 11–23 (*Ju* 1953).

Investigates in particular "linear dissipative p cesses." Postulating that macroscopic observatic are gross, i.e. that the macroscopic behaviour of large system is specified with a very small numb of macro-observables and that their observed valu are given by suitable time averages, it is conclud that macro-observables are approximately one-valu integrals of motion in M. S. Green's sense [Abstr. 86 (1952)] and that they have finite mutual correlatio On the basis of these results the author attempts reformulate the equation of motion in classic mechanics (Liouville's equation) in terms of t observed values of macro-observables. In order do this, a macroscopic counterpart of the pha space and that of a distribution function in it a introduced. Next the secular motion of the macr scopic distribution function is calculated. In th way the general Brownian motions underlying irr versible processes are disclosed and their equation motion is obtained: a Fokker–Planck equatio This equation is seen to agree exactly with that recent given by M. S. Green, who studied the prese problem from the microscopic point of view as wel but in his case, because of some important assump tions, it was no longer necessary to refer to the equa tion of motion in mechanics. Finally some discussio are given on the origin of the "Markoffian character of the macroscopic motion and on the relation of th present theory to Hashitsume's semi-phenomeno logical one. A

530.162 : 539.1

The statistical mechanics of assemblies of axiall symmetric molecules. *See Abstr.* 4777–8

GENERAL MECHANICS . MECHANICS O SOLIDS 531

531.258 : 518.

4211. The conditions for the solution of an electrica model of the elastic plate. K. WOTRUBA. *Czech. J Phys.*, **2**, 56–64 (1953) *In Russian. Summary* (1 *p.*) *i German.*

The calculation of the stresses and strains in elastic plates with free edges is discussed with regard t electrical models. The sections deal with the history of the problem, conditions for solution in differential and in difference form, the electrical model of the homogeneous and of the inhomogeneous biharmonic differential equation, the model of the boundary conditions for the bending and for the bending moment, the model for the Kirchhoff free edge condition (a third-order differential equation), the model of the effective area and of the resulting moments and shears and the components of the tension tensor. The use of the electrolytic trough for solving the biharmonic differential equation is discussed in brief. T. J. REY

531.259.2

4212. The second boundary condition of the theory of elasticity for annular regions. F. KROUPA. *Czech. J. Phys.*, **1**, *No.* 3–4, 137–46 (1952).

New methods have recently been applied to solve plane problems of the mathematical theory of elasticity rendering possible the practical solution even with more complicated boundary conditions. This method, worked out mainly by N. I. Muskhelishvili (1949), uses the properties of analytic functions of a complex variable and has already made possible the solution of many practical problems. In this paper it is used for the general solution of annular regions with displacements specified on its boundaries, and a specialization is carried out for two practical examples (torsional and radial rubber dampers). A.

531.66

4213. On the coefficient of restitution. E. TAKEDA. Note in *J. Phys. Soc. Japan*, **8**, 790 (*Nov.–Dec.*, 1953).

Pendulum experiments with 3 cm spheres of glass, ivory, copper and lead show how the coefficient of restitution between two spheres of the same material decreases as the relative velocity before impact increases, the variation being especially marked as the velocity tends to zero. J. G. OLDROYD

MECHANICAL MEASUREMENTS 531.7

531.717.3 : 621.317.39 : 621.383

4214. The photodianode. G. DELOFFRE, E. PIERRE AND J. ROIG. *C.R. Acad. Sci.* [*Paris*] **237**, 1507–9 (*Dec.* 9, 1953) *In French.*

The use of the two anodes in a vacuum phototube with suitable geometry enables the relative anode currents to be used as a measurement of the displacement of a light spot on the cathode. The tube is of use for the precision measurement of small displacements or rotations. G. F. J. GARLICK

531.732 : 536.483

4215. Liquid level indicator for condensed gases at low temperatures. W. E. WILLIAMS, JR AND E. MAXWELL. *Rev. sci. Instrum.*, **25**, 111–14 (*Feb.*, 1954).

The instrument described is designed to measure, indicate, record and control the level of liquefied gases inside a closed vessel. It is especially designed for use at low temperatures with liquefied gases such as nitrogen, oxygen, hydrogen and helium. It operates on a capacitance principle, and makes use of the difference in dielectric constants of the liquid and vapour. The sensing element is a cylindrical capacitor whose capacitance is a function of the height of the liquid column. The sensing capacitor is one element of an automatically balanced bridge which both indicates and records the liquid level. An over-all accuracy of $\pm 1{\cdot}0\%$ has been obtained. The sensitivity is adequate for use where the difference in dielectric constants of the liquid and vapour is 0·05 or greater. The instrument also incorporates a control function and supplies a controlled air pressure to a pneumatically operated valve for maintaining the level at a predetermined point. A.

531.752 : 541.123.5

4216. Adsorption studies on clay minerals. III. A torsion pendulum adsorption balance. E. W. GELEWITZ AND H. C. THOMAS. *Rev. sci. Instrum.*, **25**, 55–7 (*Jan.*, 1954).

For Pt II see Abstr. 4436 (1953). The construction, operation and inherent errors of a quartz fibre torsion pendulum balance are described. Determinations of the period of the pendulum with an accuracy of 50 μsec are easily possible. These determinations make possible the indirect weighing of a two-gram sample to 0·1 mg. A.

531.752 : 621.317.79

4217. Ultra-rapid electronic balance. A. JEUDON. *Bull. Sci. Assoc. Ingén. Montefiore* [*A.I.M.*] **66**, 831–43 (*Nov.*, 1953) *In French.*

The speed of operation of conventional balances is examined in terms of an electrical analogue and compared with the electronic one developed from the analysis. A scale pan moves a soft-iron armature between two inductors forming the arms of a 10 kc/s bridge. The out-of-balance current is amplified, rectified, amplified again as a d.c. signal and finally applied to an electrodynamic motor, similar to a moving-coil loudspeaker, which applies a restoring force to the pan assembly. The motor current is the measure of weight. Hunting of the system is largely prevented by a phase corrector in the feedback circuit, so that up to 50 weighings per second are possible. The practical limit is set by the mechanisms for conveying the objects to the balance. The model described has a capacity of 30 g with accuracy better than 0·5 g but can be adapted to cover 5–200 g. Practical applications are described: (1) to a letter cancelling machine which automatically rejects understamped letters and works at 10 letters per second, (2) to a casting weighing machine. E. D. HART

531.754 : 539.166.9

4218. Precision measurement of uniformity of materials by gamma-ray transmission. A. I. BERMAN AND J. N. HARRIS. *Rev. sci. Instrum.*, **25**, 21–9 (*Jan.*, 1954).

The uniformity of the product of thickness and density (i.e. mass per unit area) of materials of constant mass absorption coefficient is determined by measurements of the variation in γ-ray transmission. The radiation is detected with a scintillation detector and vibrating-reed electrometer. For a given incident intensity, maximum sensitivity is attained when a source is chosen which emits γ-rays whose mean free path in the material under investigation equals the thickness, assuming the detector response is a slowly varying function of quantum energy. This optimum condition for cobalt-60 radiation obtains for thicknesses of 3, 1 and $\frac{1}{2}$ in. of Al, Fe and U, respectively; using a 1-curie source, variations of $0{\cdot}01\%$ in the uniformity of plates of these thicknesses have been measured. The method may be applied also to the scanning of curved surfaces and extended materials where the source and detector cannot permanently be fixed with respect to each other. For this latter case, the problem of compensating for the effect of misalignment of source and detector is considered. A.

531.776 : 621.317.39

4219. Stroboscopic measurement of speed. P. K. HERMANN. *Elektrotech. Z.* [*ETZ*] *A*, **74**, 698–702 (*Dec.* 11, 1953) *In German.*

After describing various types of stroboscope, it is pointed out that the readings may be ambiguous. If the flash frequency is adjusted until the machine under test appears stationary, the actual frequency is either equal to the flash frequency or is an integral multiple of it. Methods are described in detail for determining the correct factor and so removing the ambiguity. R. G. JAKEMAN

531.787 : 539.893

4220. Manometer with free piston for the absolute measurement of high pressures up to 10^4 kg/cm^2 and associated secondary arrangements for the electrical measurement of these pressures. JAS. AND JAC. BASSET. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 57 A–64 A (*Jan.*, 1954) *In French.*

A robust form for laboratory use in which the piston is free to oscillate or rotate is described in detail. The range is 200–10^4 kg/cm^2, precision 1/2500 and sensitivity 10^{-4} of the measured pressure. Two forms of electrical secondary gauges, depending on the unbalance of a Wheatstone bridge in which the manometric resistance is one arm, are described. They are practically free from hysteresis, are sensitive to 1/10 kg/cm^2 and are accurate to 1%. S. WEINTROUB

531.787

4221. A precision multiple-mercury-column manometer. J. R. ROEBUCK AND H. W. IBSER. *Rev. sci. Instrum.*, **25**, 46–51 (*Jan.*, 1954).

The 200 atm. mercury manometer described in previous papers [e.g. *Rev. sci. Instrum.*, **10**, 179 (*June*, 1939)] is studied experimentally and revised, especially by removing the mercury reservoirs from the measuring system. A rotating loaded piston is used to provide a constant test pressure, and details as to its construction and use are given, as also for the toluene pump, valves, unions, Invar tape and cathetometers. The temperature control of the manometer and the management of its fluids are described. The barostat piston was known to vary 2 to 3 parts per 10^4 in. cross-section. By means of a screw-driven plunger the barostat was held manually at the same vertical position during each of a series of 8 readings of the barostat pressure. The maximum divergence from the mean of the series is 0·83 part per 10^4, and the average of the absolute values of the divergences from the mean is 0·30 part per 10. It is concluded that the manometer can be relied on to measure a pressure of about 200 atm. to within 1 part in 10^4. A.

531.787

4222. Measurement of pressure transients. R. T. ECKENRODE AND H. A. KIRSHNER. *Rev. sci. Instrum.*, **25**, 33–40 (*Jan.*, 1954).

A general review of fluid pressure transient measurement and instrumentation is presented. The review is designed to acquaint the reader with the basic problems encountered in transient measurement and to discuss the various types of pressure gauges available. The measurement problems include such topics as frequency response, thermal and electrical stability, calibration techniques and interpretability of results. Some of the more important gauge types covered a mechanical, piezoelectric, condenser, strain, indu tance and optical. The discussion of these gaug includes a critical evaluation of the important chara teristics of each, followed by a table comparing the with each other on the basis of these characteristic With this background, the choice of a gauge be suited for a particular transient measurement proble should be facilitated.

MECHANICS OF FLUIDS 532

532.12 : 534.222.1

4223. Some results relating to the compression o water in a shock wave. J. DAPOIGNY, J. KIEFFER AN B. VODAR. *C.R. Acad. Sci.* [*Paris*] **238**, 215–1 (*Jan.* 11, 1954) *In French.*

The density of water in a shock wave and the spee of the wave have been measured photographicall by the aid of X-rays, the absorption of the rays bein a measure of the density. The results agree with thos obtained by Schall [Abstr. 8521 (1950)], and a com parison of the results with those obtained by Bridgma show that the temperature in the shock wave does no penetrate into the region of possible solidification temperature determinations are, however, considere to be very insufficient. J. S. G. THOMA

532.1

4224. Viscosity difference between *ortho-* and *para* deuterium at low temperatures. E. W. BECKER R. MISENTA AND O. STEHL. *Z. Phys.*, **136**, *No.* 4 457–62 (1953) *In German.*

It was found, with the aid of the apparatus describe in Abstr. 4633 (1953), that, within the range 66·7–98·0% *o*–D_2, the viscosity of D_2 increases as the *o*–D_2 content increases. This would corroborate the authors' hypothesis that the viscosity phenomena in *ortho* and *para* H_2 and D_2 depend mainly on the dynamic difference between the rotating and non rotating molecules. F. LACHMAN

532.13 : 537.2

4225. Theory of the effect of an electric field on liquid viscosity. R. EISENSCHITZ and G. H. A. COLE *Phil. Mag.*, **45**, 394–400 (*April*, 1954).

If an insulating liquid is placed between the plates of a condenser the electric field gives rise to induced intermolecular forces which are proportional to the square of the field strength. On account of these forces there is a change in the radial distribution function. The field effect on the distribution function is calculated for the case of thermal equilibrium and for steady flow. The corresponding increment in viscosity compares not unfavourably with experimental facts. A.

532.133

4226. Study of the effect of electro-viscosity: variation of K with the dielectric constant of the solvent. J.-B. DONNET AND P. MARGUIER. *C.R. Acad. Sci.* [*Paris*] **237**, 1519–21 (*Dec.* 9, 1953) *In French.*

It has been found that the constant K of the Einstein equation $\eta_r = 1 + K\phi$ varies in a hydrosol of carbon black when more and more C_2H_5OH is added to the

queous phase. An almost identical curve is obtained or the hydrosol when its temperature changes from 5° to 90·42°c. The temperature-induced change of is reversible. F. LACHMAN

532.14 : 534.22 : 541.64

4227. The density and the ultrasonic velocity in benzene solutions of methyl methacrylate at different polymerization stages. Y. WADA AND S. SHIMBO. *J. Phys. Soc. Japan*, **9**, 78–81 (*Jan.–Feb.*, 1954).

Measurements of density and ultrasonic velocity have been performed in dilute benzene solutions of methyl methacrylate of different polymerization stages, including the monomer and the final product of polymerization. The apparent molal volume and the apparent molal compressibility have been computed from the experimental results. The amount of polymerization (the ratio of reacted monomers to initial ones) of each intermediate product has been estimated from the molal properties, taking account of the fact that these molal properties of polymer with high polymerization degree are independent of polymerization degree. The values of the amount of polymerization, estimated from each of the molal properties, are in satisfactory agreement with each other and also with the value computed from the ultrasonic absorption in the previous paper [Abstr. 5343 (1953)]. A.

532.51 : 534.01 : 539.31 : 530.145

The application of Fourier transforms in physical problems. *See Abstr.* 4157

532.517

4228. Critical Reynolds number and flow permeability. G. J. PLAIN AND H. L. MORRISON. *Amer. J. Phys.*, **22**, 143–5 (*March*, 1954).

Liquids of three different viscosities have been used in determining the flow permeability of fourteen media composed of spherical glass beads. Darcy's law has been found to hold for a Reynolds number up to 75. Three methods are given for determining the average bead diameters. A.

532.517.4

4229. On the spectrum of energy in turbulent shear flow. C. M. TCHEN. *J. Res. Nat. Bur. Stand.*, **50**, 51–62 (*Jan.*, 1953).

A turbulent flow with a given spatial pattern of mean motion invariant with time is treated. No solid boundary is considered. By means of the Fourier analysis of the Navier–Stokes equation, it is possible to obtain an equation of energy balance in spectral terms. This involves the following functions: Viscous dissipation, transfer, production, convection and diffusion. The first two functions are common to the isotropic and homogeneous turbulence without mean motion. Assuming that eddies controlled by inhomogeneity are much larger than those controlled by anisotropy, stationary spectral laws are obtained for small eddies in the viscous and nonviscous ranges. The agreement between theory and experiment is shown. A.

532.517.4

4230. Turbulent processes as observed in boundary layer and pipe. G. B. SCHUBAUER. *J. appl. Phys.*, **25**, 188–96 (*Feb.*, 1954).

Certain statistical properties of turbulence observed in a boundary layer and in fully developed pipe flow are compared. Differences and likenesses are shown, and in particular certain common properties are found which appear to be indicative of processes governing the finer structure and controlling the origin, form and life cycle of turbulent motions. An attempt is made to point out some of these processes. Attention is called to a region of high turbulent activity near the wall. A.

532.59 : 551.311.18

4231. Reflection and transmission coefficients for waves entering or leaving an icefield. J. B. KELLER AND M. WEITZ. *Commun. pure appl. Math.*, **6**, 415–17 (*Aug.*, 1953).

CAPILLARITY 532.6

532.612

4232. On the application of the drop-weight method in the study of surface tension as a function of time. M. QUINTIN AND P. BIRO. *C.R. Acad. Sci.* [*Paris*] **238** 471–3 (*Jan.* 25, 1954) *In French.*

The authors have used the method for measuring surface tension at various times of surface formation. The effect of time of formation on the value obtained can therefore be studied. The very well defined experimental curve shown proves that the method is very suitable. T. C. TOYE

532.64

4233. Hysteresis of contact angle of water on paraffin. Effect of surface roughness and of purity of paraffin. B. R. RAY AND F. E. BARTELL. *J. Colloid Sci.*, **8**, 214–23 (*April*, 1953).

The experimental results show that when very thin films of purified paraffin were formed in vacuum by volatilization on smooth glass surfaces and water drops were placed upon them, the advancing and the receding contact angles were sensibly the same, 112°; that is, hysteresis effects did not exist on these very thin and very smooth surfaces. Measurable hysteresis effects from 5° to 35° were found for less smooth films, and coatings of appreciable thickness formed in vacuum, in nitrogen or in air, whether from a melt or by volatilization. The magnitude of the hysteresis effects appeared to be closely associated with the microscopic roughness of the surfaces, the roughness adding to the magnitude of the advancing angle but subtracting from the receding angle to the same degree, so that the average angle remained the same for paraffin films of different roughnesses but of the same degree of purification. The average contact angle for purified paraffin was slightly larger than the average angle for unpurified paraffin. A.

532.65

4234. Oscillating droplets. J. B. LEWIS AND H. R. C. PRATT. Letter in *Nature* [*London*] **171**, 1155–6 (*June* 27, 1953).

A study of solute transfer to and from droplets has been carried out on a number of solvents and solutes, measurement of interfacial tensions being made by the pendant drop method. The oscillations of solvent droplets in water and of water droplets in

solvent phases which were observed are assumed to be more effective in promoting transfer than molecular diffusion. T. C. TOYE

MOLECULAR THEORY OF LIQUIDS 532.7

532.7 : 519.2

4235. On the molecular distribution functions of a one-dimensional fluid. I. A. RAMAKRISHNAN. *Phil. Mag.*, **45**, 401–9 (*April*, 1954).

The results of Salzburg, Zwanzig and Kirkwood relating to the molecular distribution functions of a one-dimensional fluid are obtained as corollaries of a recent paper by the author and P. M. Mathews [Abstr. 8181 (1953)]. These functions are identified as product densities and the problem is considered from the standpoint of stochastic theory. A.

532.7 : 534.22 : 536.4

4236. On molecular sound velocity of liquids. I. Consideration on the Rao's relation between the temperature coefficient of sound velocity in and the coefficient of thermal expansion of liquids. T. KISHIMOTO AND O. NOMOTO. *J. Phys. Soc. Japan*, **9**, 59–65 (*Jan.–Feb.*, 1954).

The temperature coefficient of the isothermal compressibility $(1/\beta_T)(d\beta_T/dT)$ and the coefficient of thermal expansion α have been computed for liquids employing the Lennard-Jones and Devonshire equation of state as improved by Wentorf, Buehler, Hirschfelder and Curtiss and their numerical tables. The computed value of the ratio of these two coefficients is about 6·5 at temperatures corresponding to $0{\cdot}9\,T_b$, where T_b means the boiling points. This gives a rough explanation of the Rao's relation between the temperature coefficient of the adiabatic compressibility β_S and the coefficient of thermal expansion α; i.e. $(1/\beta_s)(d\beta_s/dT) = 7\alpha$. Re-examination of Rao's relation has been performed on many organic liquids, some liquefied gases and some molten metals employing existing ultrasonic velocity data. The ratio $(1/\beta_s)(d\beta_s/dT) : \alpha$ is about 7 in organic liquids, about 5 in liquefied gases and rather scattered in molten metals. A.

532.7 : 534.22 : 536.4

4237. On molecular sound velocity of liquids. II. Dependence of the thermal expansion coefficient and the temperature coefficient of compressibility of liquids on the boiling point. T. KISHIMOTO AND O. NOMOTO. *J. Phys. Soc. Japan*, **9**, 66–72 (*Jan.–Feb.*, 1954).

The coefficient of thermal expansion α and the temperature coefficient of isothermal compressibility $(1/\beta_T)(\partial\beta_T/\partial T)_p$ of liquids calculated on the basis of the Lennard-Jones and Devonshire equation of state as improved by Wentorf, Buehler, Hirschfelder and Curtiss have been shown to be inversely proportional to the boiling point of the liquids, if the liquids are considered at absolute temperatures $T = \text{constant} \times T_b$, where T_b means the boiling points. At temperatures $T = 0{\cdot}9T_b$, theoretically $\alpha = 0{\cdot}140/T_b$ and $(1/\beta_T)(\partial\beta_T/\partial T)_p = 0{\cdot}865/T_b$. If the same temperature dependence is assumed for the adiabatic compressibility β_s as for β_T, there results for the temperature dependence of the sound velocity in liqu $(1/V)(\partial V/\partial T)_p = -0{\cdot}36/T_b$. These linear dependen of the coefficient of thermal expansion, the te perature coefficient of the adiabatic compressibili and the temperature coefficient of the sound veloc on the reciprocal of the boiling point have be investigated in many organic liquids, some liquefi gases and some molten metals, employing existi ultrasonic velocity data, and proved to be true rough approximation, though the measuremen do not correspond to temperatures satisfyi $T = \text{const.} \times T_b$. The experimental values of t proportionality factors, however, proved to about three times larger than the calculated on i.e. $\alpha = 0{\cdot}41/T_b$, $(1/\beta)(\partial\beta_s/\partial T)_p = 2{\cdot}8/T_b$ a $(1/V)(\partial V/\partial T)_p = -1{\cdot}2/T_b$.

532.7 : 534.22 : 536

4238. On molecular sound velocity of liqui III. Consideration on the Rao's relation on the d pendence of molecular sound velocity on critic constants. O. NOMOTO AND T. KISHIMOTO. *J. Phy Soc. Japan*, **9**, 73–7 (*Jan.–Feb.*, 1954).

Theoretical derivation of the Rao's relation $R_V = a(T_c/M)^{1/6}v_c$ has been performed on the basis of t Lennard-Jones and Devonshire liquid model ar using Wentorf, Buehler, Hirschfelder and Curtis equation of state. Here R_V means the molecul sound velocity defined by $R_V = (M/\rho)V^{1/3}$, with M the molecular weight, ρ the density and V the sour velocity; T_c and v_c mean the critical temperature ar the critical volume respectively, and a is an empiric constant with average value 2·68, according to Rao The theoretical value of a obtained in this paper 4·64. Rao's relation has been re-examined fo organic liquids and some liquefied gases, employin existing ultrasonic velocity data, and the followin average values have been obtained: $a_{exp} = 2{\cdot}86$ (o five liquefied gases), $a_{exp} = 2{\cdot}69$ (on 21 organi liquids except alcohols, acids and acetonitrile). Th a_{exp} for alcohols and acids are somewhat lower, th lowest example being $a_{exp} = 1{\cdot}825$ for acetic acid These substances are known to be associated liquid and show extremely low values of R_V, deviating fro the additivity rule of R_V for atomic increments o bond increments. This is also the cause for the lo values of a_{exp} in alcohols and acids. The averag value for 27 organic liquids including alcohols acids and acetonitrile are $a_{exp} = 2{\cdot}60$. A modifica tion of Rao's relation has been proposed in the form $R_V = b(\gamma T_c/M)^{1/6}v_c$, where γ means the ratio of th specific heats. The constant b is theoretically 4·4 and the average experimental value for 3 liquefie gases proved to be 2·53, and for 13 organic liquid 2·53. The average value for 11 organic liquid excluding alcohols and acids proved to be 2·56. A

532.712.08

4239. A convenient small osmometer. G. A HANKS AND S. G. WEISSBERG. *J. Res. Nat. Bur. Stand.* **49**, 393–6 (*Dec.*, 1952).

A small, rugged osmometer that is relatively easy to assemble and use is described. Typical data obtained with polystyrene solutions are presented Performance in comparison with other osmometers is discussed. A

532.72

4240. Covolume effect and diffusion theory of strongly concentrated electrolytes in aqueous solutions. H. FALKENHAGEN AND E. SCHMUTZER. Note in *Naturwissenschaften*, **40**, *No.* 23, 602–3 (1953) *In German.*

A study of diffusion in strong electrolytes gives a formula for diffusion for the case of simple electrolytes which appears very promising. T. C. TOYE

532.73–2

4241. Liquid-liquid extraction. A critical survey of the literature dealing with the mechanism of transfer of solutes across phase boundaries with special reference to liquid-liquid interfaces. J. B. LEWIS. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. CE/R*910, 22 *pp.* (1953).

The literature dealing with the theory of mass-transfer between two liquid phases is critically examined. The analogous cases of mass transfer in solid-liquid and in gas-liquid systems, and of heat transfer, are also considered. It is shown that the Whitman two-film concept, which is frequently used as the basis of approximate correlations of experimental data, is only strictly correct when transport to the interface is by molecular diffusion and any chemical reaction faster than this. Under conditions of high turbulence transport to the interface may be by eddy diffusion, the transfer rates being then independent of the molecular diffusion coefficients. Since eddy transfer is much more rapid than molecular diffusion there is more likelihood of a chemical step being rate-determining under these conditions. The same system may thus be diffusion-controlled at low degrees of turbulence and chemically controlled at high degrees of turbulence. The properties of liquid-liquid interfaces are briefly reviewed, attention being drawn to the difference between the interfacial and bulk phase properties of the solvents and solutes. Bibliography of 194 references. A.

532.74

4242. Structure differences between the melts of $AlPO_4$ and SiO_2. A. DIETZEL AND H. J. POEGEL. Note in *Naturwissenschaften*, **40**, *No.* 23, 604 (1953) *In German.*

Seven crystalline modifications of $AlPO_4$ are known which correspond in structure and very closely in transformation temperature with the seven modifications of SiO_2(=$SiSiO_4$). The melting point of $AlPO_4$ is, however, ~300 deg higher than that of SiO_2; the liquid is of low viscosity and cannot be quenched to a glass. From this and the behaviour of melts containing Na_2O it is concluded that the melt is ionic aluminium phosphate, without the four-fold co-ordination of Al characteristic of the solid phases.

A. J. C. WILSON

532.74

4243. A competitive method of determining association constants. R. FOSTER. Letter in *Nature* [*London*] **173**, 222 (*Jan.* 30, 1954).

The theory of a method of determining association constants is described which involves comparison of the optical densities of two solutions at a particular wavelength. The method gives good results and compares favourably with that of Benesi and Hildebrand [*J. Amer. Chem. Soc.*, **71**, 2703 (1949)] which involves measurements on a series of solutions.

T. C. TOYE

533.75

4244. The second virial coefficient of benzene. II. A. E. KORVEZEE. *Recueil Trav. chim. Pays-Bas*, **72**, 483–9 (*June*, 1953).

Recent experimental evidence allows the fixing of the constants in the $B(T)$ relation for benzene as given in an earlier paper [Abstr. 1547 (1952)]. The present expression is supposed to represent this second virial coefficient to within 25 cm^3/mole from room temperature to well over the boiling point. A.

532.77

4245. On the interpretation of cryometric curves. Y. DOUCET. *J. Phys. Radium*, **14**, 733–4 (*Dec.*, 1953) *In French.*

Raoult's law is a limiting law even for ideal solutions. Alternative expressions are derived from the condition of thermodynamic equilibrium for the cases of a dilute solution, a general binary solution and the case where both solvent and solute are completely dissociated. The system $AgNO_3$–KNO_3 has been studied in connection with this last. When the solvent is a hydrated salt, use is made of entropy considerations; the law for ideal solutions can be obtained on the assumption that solvent and solute are statistically indistinguishable. A. J. TAYLOR

532.77

4246. The volumes of mixing of some nonpolar liquids. R. THACKER AND J. S. ROWLINSON. Letter in *J. chem. Phys.*, **21**, 2242–3 (*Dec.*, 1953).

Prigogine has predicted [Abstr. 3918 (1953)] that solutions of non-polar molecules of equal size but unequal energies of interaction should have a positive excess free energy and negative excess volume. The maximum volume change has been plotted against the difference in boiling points of the two components for four hydrocarbon solutions and Prigogine's prediction confirmed. T. C. TOYE

532.77

4247. Experiments on polymer solution in inhomogeneous electrical fields. P. DEBYE, P. P. DEBYE, B. H. ECKSTEIN, W. A. BARBER AND G. J. ARQUETTE. Letter in *J. chem. Phys.*, **22**, 152–3 (*Jan.*, 1954).

The polymer molecules will concentrate at places of highest field strength, equilibrium being attained after a transition period in which the molecules move in the inhomogeneous field according to their combined polarizability and mobility. A brief description is given of two experiments with a 1% solution of polystyrene (mol. wt. 600 000) which demonstrate the effect by observation, in one, of the changing electrical capacity of a cylinder and central fine wire with the solution between on application of a high potential, in the other, of the diffraction spectrum produced by passing a narrow beam of light over a closely set parallel group of razor-blade edges (immersed in the solution) between which an an oppositely placed flat plate a high potential has been applied. Possible use of the effect for the determination of molecular weights is discussed. W. GOOD

532.782

4248. Critical supercooling of pure water droplets by a new microscopic technique. G. M. POUND, L. A. MADONNA AND S. L. PEAKE. *J. Colloid Sci.*, **8**, 187–93 (*April*, 1953).

Very pure water droplets of 10–15 μ in diameter were condensed in silicone oil to form an emulsion. A portion of this emulsion was placed on the specially designed cold stage of a Bausch and Lomb Research Metallograph and cooled to a low temperature. Temperature of the emulsion was measured by a small thermocouple, and freezing of the droplets was detected by observation with polarized light. The supercooling that is critical for ice formation was observed to be -40 ± 2°C, in agreement with the results of Schaefer and of Cwilong. There was usually no marked change in the droplets upon solidification. A.

MECHANICS OF GASES 533

533.15

4249. Diffusion in $CO_2 - CH_4$ mixtures to 225 atmospheres pressure. Q. R. JEFFRIES AND H. G. DRICKAMER. *J. chem. Phys.*, **22**, 436–7 (*March*, 1954).

Diffusion coefficients have been measured in two mixtures of CO_2 and CH_4: (1) 50 mole % CO_2–50% CH_4; (2) 75 mole % CO_2 – 25 mole % CH_4. C^{14} tagged CO_2 was used, so that no gradient in chemical composition was necessary. For the first mixture the results agreed with Enskog's dense gas theory at all temperatures and pressures. For the 75% CO_2 mixture at 25°C there was a positive deviation from theory, corresponding to the increased importance of glancing collisions for CO_2 near saturation. The results are consistent with the authors' previous data for self-diffusion in the two pure gases. A.

533.2 : 523.161

The expansion of a gas-cloud into a vacuum. *See Abstr.* 4106

533.21

4250. The compressibility of gases. VII. Argon in the temperature range 0–600°C and the pressure range 10–80 atmospheres. F. WHALLEY, Y. LUPIEN AND W. G. SCHNEIDER. *Canad. J. Chem.*, **31**, 722–33 (*Aug.*, 1953).

For Pt VI, see Abstr. 7608 (1951). The virial coefficients of argon have been measured in the temperature and pressure range described. "Best" values of the virial coefficients have been computed from all measurements reported in the literature. A.

533.275

4251. Error and accuracy in thermocouple psychrometry. J. L. MONTEITH. *Proc. Phys. Soc.* [*London*] *B*, **67**, 217–26 (*March*, 1954).

Discusses the main sources of error in the determination of vapour pressure with a thermocouple psychrometer. The predictions of theory and the results of experiment lead to no general agreement on the value of the constant in the classical psychrometer equation. A new derivation of the equation suggests a reduction of the commonly accepted value by the power of the ratio of diffusion coefficients f heat and water vapour. An expression is derive for the radiation error due to the difference of ter perature between the wet bulb and its surrounding Conduction of heat along the thermocouple wir and extraneous radiation produce errors for whic an expression is derived for a particular thermocoup model. Finally, wet-bulb temperature errors a related to the corresponding vapour pressure errors

533.4

4252. A logarithmic barometer. V. H. YNGV *Rev. sci. Instrum.*, **25**, 43–5 (*Jan.*, 1954).

The design of a barometer is described whic achieves a logarithmic response over a wide range o pressures by the use of two fluids and a tube o varying cross-section. Application of the princip to barometers with other useful non-linear scales discussed. A

533.5 : 531.788 : 536.48

4253. Measurement of high vacuums at low tem peratures. M. P. GARFUNKEL AND A. WEXLER. *Re sci. Instrum.*, **25**, 170–2 (*Feb.*, 1954).

The general usefulness of the helium mass-spectro meter leak detector for measuring very low pressure at liquid helium temperatures is discussed. Th required relations between mass flow, pressure pumping speed, and the dimensions of the apparatus in which thermomolecular flow plays a major rôle are derived. It is shown that the exchange gas i liquid helium calorimeters can be pumped out t pressures below 1×10^{-10} mm Hg. A

533.5 : 531.788.

4254. A simple thermionic vacuum gauge. G. K. T CONN AND H. N. DAGLISH. *J. sci. Instrum.*, **31**, 95–6 (*March*, 1954).

A description is given of a gauge which, because of the form of the anode, is very easy to construct The release of photoelectrons which limits the use of a conventional thermionic gauge at low pressures is surmounted by using a single wire as the ion collector. At pressures of the order of 10^{-4} mm Hg or less the instrument is linear and has a sensitivity of about 13 μA per μ pressure per mA anode current A

533.6.011

4255. Some particular solutions of compressible-flow equations for arbitrary-density relations. I. IMAI. Note in *J. Phys. Soc. Japan*, **18**, 799–801 (*Nov.–Dec.*, 1953).

In a recent paper Krzywoblocki has discussed a particular solution of the hodograph equation for an adiabatic gas flow corresponding to the flow due to a point-vortex. It is now pointed out that this problem had already been discussed by Ringleb [*Z. angew. Math. Mech.*, **20**, 185 (1940)] and that the difference between the results obtained by the respective authors is attributable to the fact that Ringleb had, without explicitly stating the fact, assumed the value 1·4 for the adiabatic index κ. It is also pointed out that formulae giving the analogous flow patterns and the flow around a semi-infinite plate have been derived

by Imai for a compressible fluid with an arbitrary pressure density relation. It is also shown that the form of the free stream line in the flow due to a point-vortex is not affected by the compressibility of the gas for any pressure-density relation and is the same as that for an incompressible fluid, a conclusion reached by Hasimoto for the assumption $p \propto \rho^{1.4}$.

J. S. G. THOMAS

533.6.011.3 : 537.533.3

4256. The imaging of gas streams by electron beams. B. SCHUMACHER. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 404–20 (1953) *In German.*

The technique of photographing gas streams, emerging from nozzles into a vacuum enclosure, by means of electron shadow pictures is described with examples. The method is useful in conditions when the (light) interferometer fails because of insufficient optical thickness. The concentration of the gas at any given point can be determined. A. H. W. BECK

533.6.011.311 : 534.231

4257. Boundary layer flow near a cylindrical obstacle in an oscillating incompressible fluid. J. HOLTSMARK, I. JOHNSEN, T. SIKKELAND AND S. SKAVLEM. Letter in *J. Acoust. Soc. Amer.*, **26**, 102 (*Jan.*, 1954).

The motion of an incompressible fluid about a fixed circular cylinder in a uniform sound field, has been found by solving the hydrodynamical equations by the method of successive approximations. The zeroth approximation gives the field of oscillation, and the first approximation gives a time-independent flow. The results have been confirmed experimentally, the case considered being that of a cylindrical obstacle in oscillating air, the axis of the circular cylinder being perpendicular to the direction of oscillation.

A. B. WOOD

533.6.011.5

4258. Extension of von Kármán's transonic similarity rule. I. IMAI. *J. Phys. Soc. Japan*, **9**, 103–8 (*Jan.–Feb.*, 1954).

An attempt is made to extend von Kármán's transonic similarity theory so as to cover the whole range of Mach number from subsonic to supersonic. First, the equations for the two-dimensional compressible flow past a slender body are reduced to

$$\frac{\partial G}{\partial \zeta} = B\left(\frac{\partial \phi_1}{\partial \xi}\right)^2 \ldots (1) \quad \text{or} \quad \frac{\partial^2 \phi_2}{\partial \eta^2} = 4B\frac{\partial \phi_2}{\partial \xi}\frac{\partial^2 \phi_2}{\partial \xi^2} \ldots (2)$$

by assuming that the perturbation velocity is small of order ε and neglecting small quantities of $O(\varepsilon^3)$. Here $\Phi = U(x + \phi)$, $\Psi = U(y + \psi)$, $\zeta = \xi + i\eta = x + i\mu y$, $\psi = \mu\chi$, $\phi + i\chi = A(\phi_1 + i\chi_1) = AG$, $\phi_1 = \phi_2 + \xi/4B$, $B = \nu A/4$, $\mu = \sqrt{(1 - M^2)}$, $\nu = 4M^2[1 + (\gamma + 1)M^2/4\mu^2]$, where Φ is the stream function, U and M are respectively the free stream velocity and Mach number, γ is the ratio of specific heats, A is a constant of order $O(\varepsilon)$, and $G(\zeta, \bar{\zeta})$, $\phi_1(\xi, \eta)$, $\chi_1(\xi, \eta)$ are $O(1)$. Then, it is shown that $B = O(t)$ for $M \neq 1$, and that $(\nu/\mu)t$ is an appropriate parameter for $M \neq 1$, where t is the thickness ratio of the body. For the case $M = 1$, either subsonic or supersonic, the procedure of successive approximation can be applied to (1). It is to be noted that (2) is exact to the order $O(\varepsilon^2)$ in contrast to the fact that the similar equation in the usual transonic approximation theory is correct only to the order $O(\varepsilon)$. Hence it is suggested that the parameter $(\nu/\mu)t$ may be used with advantage in place of the usual transonic parameter $(\gamma + 1)t/\mu^3$ or $(\gamma + 1)t/(1 - M^2)^{3/2}$. Finally, Liepmann and Bryson's experimental data on the transonic flow past wedge sections are analysed using the parameter $(\nu/\mu)t$. A.

533.6.011.5

4259. Experiments on supersonic flow over flat-nosed circular cylinders at yaw. I. M. HALL. *Phil. Mag.*, **45**, 333–43 (*March*, 1954).

The flow pattern around flat-nosed circular cylinders at yaw was investigated by rotating the body about a line in the free-stream direction and taking schlieren photographs at different positions of the body. It was found that the shape of the bow shock wave was practically unaltered by yaw, except for the nose regions, but the separation bubble at the shoulder was considerably distorted. Even for small angles of yaw there was a region on the suction side of the body where there was no reattachment. On the lee side of the body there was a wake which was compared with the vortex wake in the two-dimensional flow past a circular cylinder started impulsively from rest. Good qualitative agreement was obtained. For high angles of yaw shock waves were found springing from the wake. A.

533.6.011.5 : 536.5

Stagnation temperature probes for high supersonic speeds. *See Abstr.* 4472

533.6.08

4260. Wind tunnel tests on seven Aerovanes. D. A. MAZZARELLA. *Rev. sci. Instrum.*, **25**, 63–8 (*Jan.*, 1954).

Each of the Aerovanes used on the 420 ft meteorology tower at Brookhaven has been tested in one or more wind tunnels. An equation of motion is defined. Comparisons are offered in terms of the period of each instrument and its damping coefficient. Other comparisons include starting speeds, stopping speeds, and the effects of ageing and unbalance on the performance of Aerovane propellers. The effect of yaw on the readings of windmill-type anemometers has been investigated further. An expression is given for the relationship between true speed, indicated speed, and angular displacement. The recovery time of an Aerovane propeller from rest can be expressed as a hyperbolic function of speed. A.

MOLECULAR THEORY OF GASES 533.7

533.7

4261. Virial coefficients and models of molecules in gases. T. KIHARA. *Rev. mod. Phys.*, **25**, 831–43 (*Oct.*, 1953).

Reviews the information about intermolecular potentials obtainable from the equation of state and from the transport properties of gases, with special reference to recent Japanese work. The values of the second and third virial coefficients for spherical molecules are given for the square well, Lennard-Jones and inverse-power repulsive potentials

and are compared with observed values for the rare gases. Consideration of transport properties (viscosity, thermal diffusion) and stability of crystal structures in the solid state indicates that the real intermolecular potential for rare gases has a wider bowl and a harder repulsive wall than the Lennard-Jones (6, 12) potential. Finally, the second virial coefficient for non-spherical molecules is evaluated for the core model and compared with experimental values. E. H. SONDHEIMER

533.7

4262. Note on the theory of transport phenomena in polyatomic gases. A. ISIHARA. Note in *J. Phys. Soc. Japan*, **8**, 799 (*Nov.–Dec.*, 1953).

Quantum mechanical formulation of the theory for gases with internal degrees of freedom, corresponding to the classical treatment of Chang and Uhlenbeck (1951). E. H. SONDHEIMER

533.7

4263. Mathematical study of Boltzmann's equation. S. MARQUET. *C.R. Acad. Sci.* [*Paris*] **237**, 1637–40 (*Dec.* 21, 1953) *In French.*

533.7

4264. A note on Wild's solution of the Boltzmann equation. M. J. KLEIN. *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 2, 293–7 (1954).

It is shown that Wild's formal solution of the Boltzmann integro-differential equation can be used to obtain Maxwell's classical relaxation behaviour of the second velocity moments of the molecular distribution function. A.

533.7

4265. The third virial coefficient of a Lennard-Jones gas by Kihara's method with tables for the 6–9 potential. L. F. EPSTEIN, C. J. HIBBERT, M. D. POWERS AND G. M. ROE. *J. chem. Phys.*, **22**, 464–8 (*March*, 1954).

Kihara has shown that the third virial coefficient of a Lennard-Jones 6–9 gas can be expressed as a convergent power series of the form $\Sigma_j \beta_j(s)\theta^{(s-6j)/s}$ with $\theta = \varepsilon/kT$. In this paper the coefficients $\beta_j(s)$, which are rather complicated double integrals, are developed and applied to the case $s = 9$. For $j < 20$ the coefficients are obtained by numerical quadrature, using high-speed computing equipment. Asymptotic formulae for arbitrary s are used to extrapolate the numerical results for $s = 9$ into the range $20 < j < 100$. Values of the normalized third virial coefficient, $C_9^{(0)}$ (θ) and its derivatives, computed from Kihara's series, are tabulated for the range $0 < \theta < 2$. An asymptotic expression for $C_s^{(0)}$ (θ) is used to extend the tables to higher values of θ. A.

533.7

4266. Transport properties of gases obeying a modified Buckingham (exp-six) potential. E. A. MASON. *J. chem. Phys.*, **22**, 169–86 (*Feb.*, 1954).

A large number of the Chapman and Cowling collision integrals have been calculated for gases obeying a modified Buckingham potential. The results are tabulated over a large temperature range, kT/ε from 0 to 200, and for four values of the parameter α, 12, 13, 14 and 15. The treatment was entirely classical, and no corrections for quantum effects were made. The results should be applicable to most simp non-polar gases, and may be used to obtain inform tion about intermolecular forces from the observ temperature dependence of gaseous transport p perties. The second approximation to the therm diffusion ratio and the third approximation to t coefficient of ordinary diffusion have been deriv according to the method of Chapman and Cowlin Evaluation of the potential parameters for speci substances and applications of the results will published later.

53

4267. Second virial coefficients of gases obeying modified Buckingham (exp-six) potential. W. RICE AND J. O. HIRSCHFELDER. *J. chem. Phys.*, 2 187–92 (*Feb.*, 1954).

The second virial coefficient has been calculated f gases obeying a modified Buckingham potenti (exp-six) (see preceding abstract). The results a tabulated over the temperature range kT/ε fro 0·40 to 400, and for seven values of the parameter from 12 to 15. The treatment was entirely classica and no corrections for quantum effects were mad A separate paper will present the evaluation of t parameters for specific substances and applications the results, together with applications of the calculate transport properties given in the preceding abstrac

533.7 : 539.1

4268. The intermolecular potentials of helium an hydrogen. E. A. MASON AND W. E. RICE. *J. chem Phys.*, **22**, 522–35 (*March*, 1954).

The parameters for helium and hydrogen of th "exp-six" potential have been calculated by use o experimental values of the second virial coefficien and viscosity coefficients. Because of the uncertaint of the quantum corrections, no low temperature dat were used in determining the parameters. Th exp-six potential is able to reproduce both the secon virial and the viscosity coefficients within experimenta error, and is thus an improvement over the simple Lennard-Jones (12-6) potential. In addition, othe transport properties are accurately predicted. A combination rule is suggested for calculation of th exp-six potential between two unlike molecules fro the potentials between two pairs of like molecules and is used to calculate a number of properties o helium-hydrogen mixtures with satisfactory results. A

533.73 : 536.2

4269. A comparative study of accommodation coefficients by the temperature jump and low-pressure methods and thermal conductivities of He, Ne, and CO_2. L. B. THOMAS AND R. C. GOLIKE. *J. chem Phys.*, **22**, 300–5 (*Feb.*, 1954).

The temperature-jump and low-pressure methods are used to determine the accommodation coefficients of He, Ne and CO_2 on platinum under conditions as closely identical as compatible with the methods. Agreement is very close for He and for CO_2, giving values centring about 0·176 for He and 0·78 for CO_2. For Ne the results are ambiguous, giving good agreement with one sequence of preparation and giving temperature jump values 25% low with another. Variability is correlated with preparation history and

ariability with time is noted by both methods. hermal conductivity values of He, Ne and CO_2 are iven and compared briefly with values in the terature. A.

533.75 : 536.71

4270. Imperfect gas as an association problem. V. WELTNER, JR. Letter in *J. chem. Phys.*, **22**, 53–4 (*Jan.*, 1954).

An equation of state is given, including the second nd higher virial coefficients, and thus expressing ormation of dimers and higher polymers. Expresions are given for the higher virial coefficients. C. TURNER

533.75 : 536.71

4271. The Mayer theory of condensation tested against a simple model of the imperfect gas. H. N. V. TEMPERLEY. *Proc. Phys. Soc.* [*London*] *A*, **67**, 233–8 (*March*, 1954).

A very simple model of an imperfect gas, analogous to the Weiss model of a ferromagnetic, is used to check various conflicting conclusions about the relationship between the condensation of an imperfect gas and the divergence of Mayer's virial series. For this model, the divergence of the virial series has no physical significance, and the interpretations of this divergence suggested by Mayer and by Born and Green are both incorrect. The model also turns out to be one for which care is necessary in going to the limit of a very large assembly. A.

VIBRATIONS . ACOUSTICS 534

534.01 : 539.31 : 532.51 : 530.145

The application of Fourier transforms in physical problems. *See Abstr.* 4157

534.13

4272. Analogue systems for free modes of oscillations of beams. K. MÍŠEK. *Czech. J. Phys.*, **1**, *No.* 3–4, 185–9 (1952).

Deals with a method of calculating an analogue system. The calculation is carried out for the *n*-th harmonic for longitudinal and torsional vibrations and for first and second overtone for transverse vibrations. The ease of excitation is compared according to dynamical rigidity. A.

534.13 : 621.372.412

4273. On the vibrations of a quartz resonator excited by a frequency modulated oscillator. H. MAYER. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 8 A–11 A (*Jan.*, 1954) *In French.*

Quartz crystal resonators of different quality (Q) can be studied in this way, the damped vibrations being displayed on a c.r.t. Experimental results are compared with existing theory [G. Hok (1948)] and agreement is established. W. BARDSLEY

534.132

4274. On the physical theory of organ pipes. H. DÄNZER AND W. MÜLLER. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 97–109 (1953) *In German.*

The vibrations of organ pipes under the influence of acoustic excitation have been studied theoretically by the method of Laplace transforms, and by means of equivalent electrical circuits. Both flue and reed pipes are considered. A. B. WOOD

534.152

4275. New apparatus for optical recording of mechanical vibrations. H. FREISE. *Z. Verein. Dtsch. Ingen.* [*VDI*] **96**, 22–6 (*Jan.* 1, 1954) *In German.*

Two pieces of equipment are described. Both are based on a spring-mounted pendulum system with eddy-current damping. One is for recording vibratory motions of up to ± 25 mm; it has a natural frequency of about 1 c/s and is critically damped. The other is for recording motions of up to ± 1 mm; there are two settings of the sensitivity, the natural frequencies being 5 and 14·4 c/s and the corresponding damping factors 0·32 and 0·09. The motion of the pendulum is recorded by an optical system on 3 in. wide photographic paper strip. H. J. H. STARKS

534.17

4276. Modulation of stationary ultrasonic waves in air. L. PIMONOW. *Ann. Télécomm.*, **9**, 24–8 (*Jan.*, 1954) *In French.*

The first part deals with the general question of modulation. It points out that superposition of vibrations (electrical or mechanical) signifies an addition of amplitudes, whereas modulation corresponds to a multiplication of amplitudes. In part two reference is made to the modulation of stationary waves of ultrasound, and in part three an outline is given of a so-called "gaseous microphone." This consists of 30 kc/s quartz source which sets up a system of stationary waves between its emitting surface and a rigid reflector a short distance away. The progressive waves from a source of audio frequency sound cross the track of these stationary waves and produce a modulation which is received by a small Rochelle salt microphone suitably placed near the stationary wave system. In a particular case mentioned in the paper the depth of modulation was about 3%. Part four of the paper deals with the theory of modulation of stationary waves. A. B. WOOD

534.21

4277. "Quartz wind" formation time. C. L. DARNER AND E. N. LIDE. Letter in *J. Acoust. Soc. Amer.*, **26**, 104–5 (*Jan.*, 1954).

This is a criticism of Bergman's comments on the work of Biquard concerning "quartz wind," i.e. the hydrodynamic flow directed away from the projector. It is stated, for example, that a time of more than $\frac{1}{4}$th sec is required for the development of the flow. Measurements by the U.S. Navy Underwater Sound Reference Laboratory have shown that the "quartz wind" certainly develops in less than $\frac{1}{50}$th sec and perhaps in a very much shorter time. A photograph obtained by the schlieren method illustrates the disturbance of heat striae by a 200 kc/s sound pulse of $\frac{1}{50}$th sec duration repeated at the rate of 2 per second. H. J. H. STARKS

534.21 : 539.3

4278. The propagation of waves in an imperfect elastic medium. M. MATSCHINSKI. *C.R. Acad. Sci.* [*Paris*] **238**, 203–5 (*Jan.* 11, 1954) *In French.*

An approx. method is given for determining the

change in waveform and the absorption due to the imperfect elasticity of the medium (plasticity is excluded). J. E. CAFFYN

534.22

4279. The modulation method of measuring dispersion of ultrasonic radiation. V. A. ZVEREV. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 791–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-133.

An electronic method is described of measuring dispersion of ultrasound which does not require the measurement of differences in sound velocity at different frequencies and is not therefore subject to the relatively large errors inherent in those measurements. T. C. TOYE

534.22 : 541.64 : 532.14

The ultrasonic velocity in benzene solutions of methyl methacrylate at different polymerization stages. *See Abstr.* 4227.

534.222

4280. Velocity of sound in glycerol. F. A. A. FERGUSSON, E. W. GUPTILL AND A. D. MACDONALD. *J. Acoust. Soc. Amer.*, **21**, 67–9 (*Jan.*, 1954).

A method of measuring the velocity of sound in liquids by determining the critical angle for the sample and a known liquid is described. The method has been used to measure the velocity of sound in glycerol. The velocity at 7·5 Mc/s and 25°c is 1964 ± 10 m/sec. The velocity for glycerol–water mixtures is also reported. A.

534.222 : 532.7

4281. The velocity of sound in water as a function of temperature and pressure. A. H. SMITH AND A. W. LAWSON. *J. chem. Phys.*, **22**, 351–9 (*March*, 1954).

The velocity of sound in water has been measured by an ultrasonic echo technique in the temperature range from −12°c to 129°c under hydrostatic pressures varying up to 9600 kg/cm². Even at the highest pressures the temperature dependence of the velocity of sound is found to be abnormal. In contradiction to certain previous results, the temperature at which the velocity of sound is a maximum is found to increase with increasing pressure. The behaviour of the sound velocity is discussed in the light of recent theories concerning the structure of water. The internal consistency of the data with existing pressure standards is also analysed. A.

534.222.2

4282. Boundary disturbances in high-explosive shock tubes. R. G. SHREFFLER AND R. H. CHRISTIAN. *J. appl. Phys.*, **25**, 324–31 (*March*, 1954).

High-velocity disturbances are observed to propagate along the walls of a high-explosive operated shock tube in advance of the plane shock. Experiments are presented which determine the dependence of the geometry, energy and velocity of the disturbance on such variables as the gas contained in the shock tube, the shock strength and the roughness and composition of the supporting boundary. A model is constructed to explain the flow within the disturbance. Arguments are presented which show the disturbance to result from radiation originating in the luminous plane shock. A.

534.222

4283. Normal reflection of shock waves from movi boundaries. R. A. ALPHER AND R. J. RUBIN. *J. ap Phys.*, **25**, 395–9 (*March*, 1954).

The problem of the reflection of a shock wa from a moving boundary is examined in an idealize one-dimensional treatment. The head-on collisio of an incident step shock wave and a piston movi at constant velocity into a gas at rest are considere in detail. The calculation involves the head-c collision of two shock waves and the subseque reflection of an altered transmitted wave from t piston. The reflected pressure is calculated for range of incident shock strengths and piston speed For a stationary piston both the absolute and exce reflected pressures are at most eight times the absolu or excess pressure of the incident shock wave (wi $\gamma = 7/5$). With a moving piston, however, th limiting factor is greater than eight, but finite f finite piston speed and infinite incident shock strengt and is infinite for infinite piston speed and fini incident shock strength. This last result holds eve in the limit of the incident wave being an acoust pulse. The method of solution for shock-wa interaction with a piston receding at constant veloci is also indicated. Although the shock is strengthene on passing through the piston rarefaction wave, t reflected over-pressure is less than that resulting fro the same initial shock wave reflecting from a stationa piston.

534.2

4284. Damped oscillations of a quartz crystal i liquids at different temperatures. S. PARTHASARATHY H. SINGH AND M. PANCHOLY. *Ann. Phys.* [*Leipzig*] 1 *No.* 6–8, 353–8 (1953).

The technique of the method already describe [Abstr. 8293 (1953)] has been considerably improved The absorption of ultrasound in liquids is muc larger than can be explained by viscosity and hea conduction alone and of the various mechanism suggested to explain the source of this extra absorp tion, the one of second viscosity, already questione by previous work, should affect the damping. Th present work shows, however, that the factor govern ing the excess absorption is not operative in damping and therefore it is thought that it cannot be analogou to viscosity. T. C. TOY

534.2

4285. Transmission of ultrasound through porou bodies in liquids. G. SCHMID AND H. KNAPP. *Z angew. Phys.*, **5**, 463–72 (*Dec.*, 1953) *In German.*

A study of transmission of ultrasound of 350 kc/ through porous diaphragms impregnated with an immersed in N/1000 KCl solution. The electrica potential produced by the relative motion of th electrolyte in the diaphragm is measured. T. C. TOY

534.2

4286. Determination of the absorption coefficient o ultrasonics in liquids by means of the thermal method E. GROSSETTI. *Nuovo Cimento*, **11**, 250–4 (*March* 1954) *In Italian.*

Measurements made for water, glycerine, vaseline oil and amyl alcohol. From an examination of the theoretical and experimental values of α/ν^2 it is seen that at the lowest frequencies the experimental value

of α/ν^2 are farther from the theoretical ones, and that the difference between the two lessens with increasing frequency. A.

534.231.3

4287. The stationary behavior of acoustic impedances. D. K. MAWARDI. Letter in *J. Acoust. Soc. Amer.*, **26**, 101 (*Jan.*, 1954).

A mathematical note on the question of finding the conditions which will make an acoustical impedance Z, referred to a surface S, stationary with respect to first-order variations in acoustic pressure p and particle velocity q. The results are applicable only to plane waves. A. B. WOOD

534.232

4288. The influence of the shape of the membrane on its acoustic radiation. I. MALECKI. *Arch. Elektrotech.* [*Warsaw*] **1**, *No.* 1, 39–66 (1952) *In Polish. Summary* (3 *pp.*) *in English.*

Expressions for acoustic pressure and radiation resistance of various membranes are compared with those of a plane circular piston membrane. It is found that the shape of the membrane has small influence on the intensity of acoustic field. In an elliptic piston membrane the decrease in radiation resistance in the range of low frequencies is more pronounced when the ratio of semi-axes is far from unity. A ring piston membrane has better directivity and lower cut-off frequency. A general formula for the radiation from the cone piston membrane is approximated by a series involving Bessel functions; the angle of the cone (near 90°) has small influence. The distribution of vibrations on the surface of a plane membrane clamped around its circumference is considered in the case when the membrane is divided by n radial nodal lines and by a number of circular lines defined by zeros of Bessel functions of the radius. The radiation resistance decreases considerably as the number of nodes increases and is given by an integral, which can be reduced to the form suitable for numerical calculations only for low frequencies. Physiological and psychological effects relative to acoustic radiation from a vibrating membrane were investigated in order to determine the tolerance for the frequency response. R. SYSKI

534.232

4289. Acoustic resistance of a moving plane emitter. D. N. CHETAEV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 3, 355–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-89.*

A mathematical paper dealing with the emission of sound from a plane plate, in an opening in a semi-infinite rigid wall, radiating into an ideal compressible fluid moving with a constant velocity which is smaller than the velocity of sound. A general expression is derived for the acoustic resistance R and reactance X of the vibrating plate, and applied to the special case of a square plate. A table of values of R and X is given for values of ka ranging from 1 to 10. A. B. WOOD

534.232

4290. Power capacity of loudspeakers. P. S. VENEKLASEN. Letter in *J. Acoust. Soc. Amer.*, **26**, 98–9 (*Jan.*, 1954).

The paper deals with a simple and useful method for defining "a realistic measure of the ability of a loudspeaker to reproduce any type of programme material without objectionable distortion." The proposed method defines power-handling capacity in terms of a power-input spectrum and a sound-pressure output spectrum which are related on the basis of a specified departure from linearity of output as a function of input. Limited experience with the listening tests. It is suggested that this method be adopted by the Institute of Radio Engineers (U.S.A.) as a standard for loudspeaker testing. A. B. WOOD

534.24

4291. Observation on the paper "Aspects of the concentration of ultrasonic energy" by A. Barone. C. KLEESATTEL. Letter in *Acustica*, **3**, *No.* 6, 407 (1953) *In German.*

A modification to a focusing combination described by Barone [Abstr. 2153 (1954)] is suggested. T. C. TOYE

534.24

4292. Two-mirror concentrator of ultrasonic waves. L. D. ROZENBERG. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 5, 1091–4 (1953). *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-146.*

The plane sound waves from a circular emitter are reflected by a convex paraboloidal mirror whose axis coincides with the axis of the emitter. The resulting divergent pencil is reflected by an ellipsoidal mirror with its long axis and one focus coinciding with the axis and focus of the paraboloid. The reflected pencil converges at a large aperture angle at the second focus of the ellipsoid. The design of such a system is considered theoretically in detail. G. F. HODSMAN

534.321.9

4293. The cavitron machine tool. C. W. HAMILTON. Letter in *J. Acoust. Soc. Amer.*, **26**, 107 (*Jan.*, 1954).

Uses an inexpensive tool in an ultrasonic vibrating head for precision cutting, drilling and grinding of hard and brittle materials such as carbides, tool steels, quartz, ferrites, glass, ceramics and sapphire. Fine surface finish and absence of local heating are among the advantages claimed. G. F. HODSMAN

534.321.9 : 534.862.4 : 621.395.62

4294. Strong demodulation in air of two ultrasounds of different frequencies. S. KLEIN. *Ann. Télécomm.*, **9**, 21–3 (*Jan.*, 1954) *In French.*

Two ultrasonic sound sources are situated 10 cm apart and facing each other. The frequency of audible sound is exactly the difference between the two ultrasonic frequencies. The intervening space is analysed and it is shown that the audible sound arises at the nodes and antinodes of pressure of the ultrasonic stationary wave system. To obtain reproduction of music and speech two systems are indicated, one utilizing frequency and amplitude modulation and the other, only frequency modulation. Circuit diagrams are given. G. F. HODSMAN

534.321.9 : 681.14

4295. Fused-quartz ultrasonic delay-line memory. D. A. SPAETH, T. F. ROGERS AND S. J. JOHNSON. *Electronics*, **26**, 151–3 (*Dec.*, 1953).

A folded path configuration in a square plate of commercial-quality fused quartz yields delays of

up to 400 μsec. The carrier frequency is about 40 Mc/s. The delayed pulse rise is $< 0{\cdot}1$ μsec and the total insertion loss is about 55 db. Spurious signal rejection is achieved by using shear crystals. Pulse repetition rates > 5 Mc/s are possible with this small structure; the system details are presented. T. J. REY (R)

534.372

4296. Supplement to the paper: "The damping of bending vibrations of thin metal sheet by adhesive layers." H. OBERST. *Acustica*, **3**, 452 (1953) [= *Akust. Beih., No.* 3 (1953)] *In German.*

See Abstr. 2171 (1954). Refers to L. Cremer in relation to the method of measurement of such vibrations, avoiding the introduction of damping due to the measuring apparatus. A. B. WOOD

534.39

4297. On the mechanical action exercised on obstacles by ultrasound. R. LUCAS AND E. GROSSETTI. *C.R. Acad. Sci.* [*Paris*] **238**, 458–9 (*Jan.* 25, 1954) *In French.*

The authors use the radiometer method to measure the pressure exerted by ultrasound of 1 mm wavelength ($N = 1{\cdot}5 \times 10^6$ c/s) on perfectly reflecting and sound absorbent surfaces in water. The dimensions of the obstacle (disk, cone of revolution, dihedral, or a sphere) are about 20 wavelengths. As absorbent coating 1 mm thick stearine or paraffin is used to cover the reflector. It is shown that this coating on a disk reduces the reflecting power to half (within 8%), indicating that $r = 0$ (total absorption) approximately for the coating. The reflecting properties of the cone of revolution (open towards the sound source), the dihedral and the sphere are within 10% of the calculated values. A. B. WOOD

534.44 : 621.317.757

4298. Single-frequency harmonic analyzer. J. B. SHERMAN. *Electronics*, **26**, 192–3 (*Dec.*, 1953).

The analyser uses a set of bandpass filters in a 400 c/s harmonic series, successively switched between the signal and a valve voltmeter preceded by a low-distortion amplifier. It enables the rapid measurement of individual harmonics to be done more readily than with a standard wave analyser, but has not the same flexibility of application. The 2nd–5th harmonics are read separately, the sum of all above is covered by a 2400 c/s high-pass filter, and a 800 c/s high-pass filter gives total distortion. Range is 0·25–100% with accuracy 2% of full scale. The full valve circuit is given but the filters which have attenuation > 80 db per octave are not detailed. E. D. HART

534.61

4299. Observations on the paper "Contribution to ultrasound measurement technique in liquids" by J. Koppelmann. E. J. POST. Letter in *Akust. Beihefte, No.* 4, *AB* 258 (1952) *In German.*

It is claimed by the writer that Koppelmann's assumption of a positive density variation in an ultrasonic field [Abstr. 8028 (1952)] has no theoretical foundation. T. C. TOYE

534.61

4300. Reply to the remarks by E. J. Post. J. KOPPELMANN. Letter in *Akust. Beihefte, No.* 4, *AB* 258 (1952) *In German.*

In reply to the criticism of E. J. Post (preceding abstract) the author points out that Bergmann h shown in *Der Ultraschall* that a positive variati occurs in liquids while in gases a lowering of dens appears. T. C. TO

534.61 : 534.322.3 : 534.51

4301. Interference method of measuring correlati coefficients of stationary noises. S. G. GERSHMA *Dokl. Akad. Nauk SSSR*, **92**, *No.* 1, 33–5 (1953) *Russian.* English translation, *U.S. National S Found. NSF-tr*-157.

An experimental method of estimating the l correlation, based on measurement of the intens of the sum of a noise with itself delayed by the amou of lag. N. L. JOHNS

534.7

4302. Remarks on a paper entitled "Multi Helmholtz resonators." H. K. DUNN. Letter *J. Acoust. Soc. Amer.*, **26**, 103 (*Jan.*, 1954).

The note criticizes a paper on the above subj by C. S. McGinnis and V. F. Albert [Abstr. 63 (1952)]—particularly in reference to the vowel theo The "physical method" and "synthetic electri theory" are contrasted. The fundamental differen in the two methods is that of "lumped" vers "distributed" constants. A. B. WO

534.81 : 534.44

4303. Use of the sound spectrograph for appraisi the relative quality of musical instruments. W. KOCK. Letter in *J. Acoust. Soc. Amer.*, **26**, 105 (*Jan.*, 1954).

Magnetic tape recordings were made of the sa musical passage played by Z. Francascatti on t violins, one a high-quality violin by Guersan and t other an inexpensive violin. Sound spectrogra analysis of the two recordings indicate (1) that t inexpensive violin shows stronger low-frequen harmonics and (2) the amount of extraneous noi which appears during passage from one note to t next is greater on the poorer violin. One mig expect that this extraneous noise would diminis the clarity of tone. It is suggested that this meth of spectrographic analysis may have useful applicati in ascertaining the physical basis for the difference quality not only in violins but also in other music instruments. A. B. WO

OPTICS . RADIATION . SPECTRA 535

535.21

4304. The pressure of radiation in a refractin medium. R. V. JONES AND J. C. S. RICHARDS. *Pro Roy. Soc. A*, **221**, 480–98 (*Feb.* 9, 1954).

Briefly discusses the theoretical prediction that th mechanical forces exerted by light on an opaque bod are proportional, other things being equal, to th refractive index of the medium in which the body immersed. An experiment to confirm this predictio is described. Light falls asymmetrically on a meta vane mounted on a torsional suspension. Th

ormal pressure of the radiation on the vane gives se to a mechanical couple, resulting in a small eflexion which is observed by means of an optical ver amplifier. The suspended system is mounted n a container which can be filled with various liquids, nd the pressure on the vane when it is immersed n a liquid is compared with the pressure on the vane n air. The intensity of radiation entering the con- ainer is the same in each instance; after the small isturbing effect of the liquid on the optics of the ystem has been allowed for, the ratio of the two ressures is found to be equal to the refractive index f the liquid, within the limits imposed by experi- nental error of $\pm 1{\cdot}2\%$ r.m.s. This result is obtained or six different liquids. A.

535.231.4 : 537.583

Optical emissivity of zirconia. *See Abstr.* 4655

535.24

4305. Light modulation with constant area. G. C. MÖNCH. *Optik*, **10**, *No.* 12, 573–7 (1953) *In German.*

A number of methods of modulation are discussed in which the cross-sectional area of the light beam is constant, unlike methods using moving apertures. Among the methods are moving step wedges, rotating polarizing filters and the use of filament and discharge lamps with a.c. current. Oscillograms illustrate the results obtainable. R. W. FISH

535.24 : 535.43

4306. A design for an absolute light-scattering photometer. L. M. KUSHNER. *J. Opt. Soc. Amer.*, **44**, 155–9 (*Feb.*, 1954).

An optical design for the receiver of a light-scattering photometer is described. The design lends itself to a simple analysis, in terms of geometrical optics, which shows that absolute measurements of the Rayleigh factor are easily made. Modifications of the receiver of a Brice–Phoenix photometer in use in this laboratory are described and analysed. A preliminary value of $46 \times 10^{-6}\,\mathrm{cm}^{-1}$ at 436 mμ and 23°c is given for the Rayleigh factor for benzene. A.

535.24 : 621.329 : 628.9

4307. New photometer room of the S.A. Eclairage Schreder at Ans-lez-Liège. P. MASSART. *Bull. Sci. Assoc. Ingén. Montefiore* [*A.I.M.*] **66**, 705–17 (*July–Aug.–Sept.*, 1953) *In French.*

The determination of the polar curve of light distribution for a fitting of large dimensions, if this is done with the normal type of mirror apparatus, requires very large and unwieldy equipment. The alternative arrangement, here adopted, is to suspend the fitting at any convenient height up to 10 m above ground level and to make measurements of the illumination, at normal incidence, along a line on the floor, from immediately below the fitting to 25 m from it in plan. In this way the relevant part of the curve can be found quite quickly and by moving the fitting about its vertical axis the iso-candela diagram can be constructed. In the installation described, a colour-corrected photo-voltaic cell is used, the various movements are remote-controlled and the illumination curve along the line of travel of the cell is traced automatically. J. W. T. WALSH

535.242 : 535.233.5

4308. Effect of color temperature on apparent brightness. R. E. HARRINGTON. *J. Opt. Soc. Amer.*, **44**, 113–16 (*Feb.*, 1954).

Two screens viewed side by side were illuminated by radiations approximating those of blackbodies of different colour temperatures and matched in brightness at photopic levels. A group of 73 observers found that less light of the higher colour temperature was needed to produce equality of brightness than would be required by the CIE normal observer. The average gain in apparent brightness was 1% per 100°K colour temperature difference in the range 5400–6300°K. The gain decreases with the age of the observer. When 27 of the observers re-matched the screen colours using a "flicker" method, no gain in apparent brightness was obtained. Thus the CIE normal observer properly predicts equality of brightness under the experimental conditions used if the observer is allowed to respond only to brightness (flicker method). If the observer has time to colour-adapt, as in continuous side-by-side screen viewing, an increase in the apparent brightness of the higher colour temperature screen results. A.

535.247 : 548.734.8

Photometry of single-crystal X-ray photographs. *See Abstr.* 5142

535.247.4

4309. On the development of an ideal photon receptor. A. LALLEMAND AND M. DUCHESNE. *C.R. Acad. Sci.* [*Paris*] **238**, 335–7 (*Jan.* 18, 1954) *In French.*

An apparatus for measuring weak light intensities is described. It consists of a photocathode, accelerating electrodes and photographic plate, enclosed in a demountable glass vacuum system. The photocathode, of $SbCs_3$ type, lies within a sealed glass envelope which can be broken after the apparatus has been lightly baked. The photocathode can then be moved into position magnetically. Barium getters and an activated charcoal trap prolong the life of the photocathode, and eliminate the necessity of refrigerating the photographic plates.

A.E.I. RESEARCH LABORATORY

535.247.4 : 522.615

Simple and accurate method of voltage stabilization for direct current compensation photometers. *See Abstr.* 4102

535.31

4310. The treatment of geometrical-optical problems in practice. H. SCHULZ. *Optik*, **10**, *No.* 10, 480–5 (1953) *In German.*

The usual procedure in lens design is to compute curvatures of surfaces to suit an appropriate choice of glass types. It is argued that the increased variety of glass types now available makes it possible to use the glass constants as disposable variables, and thereby to use only curvatures of a standard range.

H. H. HOPKINS

535.313

4311. Aplanatic systems composed of two mirrors. B. JUREK. *Czech. J. Phys.*, **2**, 128–38 (1953) *In Russian. Summary* (300 *words*) *in English, with references to mathematical expressions in Russian text.*

Conditions governing aplanatism of a two mirror

system are derived. Special cases considered include systems with one spherical, one aspherical mirror, and two aspherical mirrors with objects at infinity or at a finite distance. R. W. FISH

535.315

4312. Some improved forms of the differential-prismatic cell. H. SVENSSON. *J. Opt. Soc. Amer.*, **44**, 140–6 (*Feb.*, 1954).

The range of linear response of differential prisms is investigated. This range can be increased quite considerably by coupling simple prisms in parallel or in series. By choosing the most favourable conditions, such compound prisms can be given a linear range equal to and greater than the refractivity difference between glass and water. This should have practical significance since solid glass prisms are more easily constructed than hollow prisms for a reference liquid. A.

535.317

4313. A system of simple equations for the paraxial computation for a triplet. F. WEIDERT. Note in *An. Real. Soc. Españ. Fis. Quím.*, **49(A)** 251–4 (*July–Aug.*, 1953) *In Spanish.*

Supplement to the article abstracted in Abstr. 2234 (1954).

535.317

4314. Tracing a normal congruence through an optical system. M. HERZBERGER AND E. MARCHAND. *J. Opt. Soc. Amer.*, **44**, 146–54 (*Feb.*, 1954).

A method is given for tracing a wave surface through an optical system having rotational symmetry. The approximation used is valid for rays in the neighbourhood of a principal ray lying in a meridian plane. A.

535.317

4315. Automatic computation of spot diagrams. O. N. STAVROUDIS AND D. P. FEDER. *J. Opt. Soc. Amer.*, **44**, 163–70 (*Feb.*, 1954).

The spot diagram is a useful device for estimating the distribution of light over an optical image. A method has been devised in which spot diagrams are obtained by an interpolation process which uses automatic computing and plotting machines. From a single object point a number of rays are traced through an optical system, providing data which determine the coefficients of high-degree polynomials. These polynomials replace the exact ray-tracing formulae and are used to calculate the intersections with the image plane of a large number of rays distributed uniformly over the entrance pupil. The coordinates of these rays on the image plane are then fed into a plotting machine which produces the spot diagram. A.

535.317.1

4316. An aplanatic singlet bounded by Descartes surfaces. B. JUREK. *Czech. J. Phys.*, **1**, *No.* 3–4, 197–200 (1952).

Combining two axially stigmatic image formations by refracting surfaces it is shown that it is possible to obtain strictly aplanatic image formation only on the following (not sufficient) conditions: (1) the media on both sides of the lens are characterized by the same index of refraction; (2) the lens satisfies at least one of the following conditions: (*a*) it is sym metrical about the plane of symmetry of the obj and resulting image (monochromatic light); (*b*) refraction shifts the image-forming bundle witho further change.

535.317.1 : 52

On telescopic star images. *See Abstr.* 4097

535.325 : 51

4317. Refractive index nomogram for dry a humid air. P. A. BRICOUT. *Canad. J. Phys.*, **22**, 243 (*March*, 1954).

The refractive index of humid air is the sum unity plus a term depending on pressure and te perature (dry air refractivity) plus another ter dependent on temperature and relative humidi (vapour refractivity). Two alignment nomogra give the values of both refractivities within a range 300 to 1100 mb. for pressure, +45°C to −40°C f temperature, 0 to 100% for relative humidit Relative errors do not exceed 1% of $(n - 1)$.

535.

4318. Secondary effects reinforcing a cause of err in spectrophotometry. R. CAYREL. *Ann. Astrophys* **16**, *No.* 6, 466 (1953) *In French.*

535.33.

4319. An oscillating and resonating spark circuit f spectrographic analysis. C. MAYORAL. Note *An. Real. Soc. Españ. Fis. Quím.*, **48(A)**, 236 (*July–Aug.*, 1952) *In Spanish.*

The circuit is designed to eliminate fluctuations the sparking voltage. L. PINCHERL

535.33.

4320. Photoelectric method of recording the chang in time of the spectra of light flashes. M. P. VANYUKO AND L. D. KHAZOV. *Dokl. Akad. Nauk SSSR*, 9 *No.* 3, 523–4 (1953) *In Russian.* English translation *U.S. National Sci. Found. NSF-tr-*158.

Briefly describes how time-resolved spectra sparks, etc., may be obtained, using a photoelectr (photomultiplier tube and cathode-ray oscillograp technique. Some examples, for argon and xeno discharges, are shown. J. D. CRAGG

535.33.03–1

4321. Infrared spectroscopy at the University Michigan. H. M. RANDALL. *J. Opt. Soc. Amer.*, 44 97–103 (*Feb.*, 1954).

Lecture delivered on occasion of award of Frederi Ives Medal to the author.

535.33.03–3

4322. Measurement of spark spectrum intensitie in the vacuum ultra-violet with a photomultiplie sensitised to fluorescence. V. W. MASLEN, M. R MEHARRY AND S. E. WILLIAMS. Letter in *Natur* [*London*] **173**, 76–7 (*Jan.* 9, 1954).

A photomultiplier with window coating of sodiu salicylate enables the vacuum u.v. spectrum to b detected by excitation of fluorescence in the windo coating. A peak voltmeter is connected to th multiplier output. Records of intermittently excite sources show good reproducibility of the spectrum in successive excitation pulses. G. F. J. GARLICK

535.33.07

4323. Spectrophotometer for the region 0·23–2·8 μ. J. DESVIGNES. *Rev. Opt.*, **32**, *No.* 12, 661–74 (*Dec.*, 1953) *In French.*

The instrument consists of a double monochromator, each half having two quartz Cornu prisms, two spherical and two plane mirrors (flint glass or rock salt prisms may be used). Alternative light sources can be focused in turn on the entrance slit by a system of quartz lenses adjustable for any wavelength. The only apparent aberration in the complete system is astigmatism. The attached photometer uses a thermopile or bolometer, a PbS cell, or a photomultiplier. A rotating mirror sector modulates the radiation falling on the detector and the output is amplified. For point by point spectrophotometry the instrument is hand-operated and the sector is arranged to alternate a standard light source with the monochromatic output. With suitable attenuation of the standard source by colour and neutral filters and a photometric wedge, a null reading is obtained on an oscilloscope at each wavelength setting. For automatic operation the standard source is not used but the amplified voltage is recorded. Extensive details are given of the geometrical optics, the mechanical construction, and the amplifier. Spectra obtained in the visible and the infrared are reproduced. S. T. HENDERSON

535.33.07 : 522.6

4324. Determination of the resolving power of a spectrograph by means of absorption lines and of emission lines. B. R. CRINÒ. *Ann. Astrophys.*, **16**, *No.* 5, 294–306 (1953) *In French.*

The resolving power of the Arcetri solar tower is found from (1) observed contours of telluric oxygen absorption lines, using a computed true contour to deduce the instrumental value; (2) the Cd emission line 6438 Å, assuming a width negligible compared with that observed (giving a smaller value); (3) theoretical considerations of diffraction at the slit and grating (giving a larger value). The second and third methods give respectively lower and upper limits to the true value and it is suggested that the use of absorption lines gives the best approximation. D. L. EDWARDS

535.33.07 : 535.243

4325. Photographic measurement of the intensity of a spectral line superimposed on a continuous spectrum. J. CABANNES. *Ann. Phys.* [*Paris*] **9**, 5–9 (*Jan.–Feb.*, 1954) *In French.*

A method is developed for the reduction from a microphotometered spectrogram of the correct intensity value for an emission line recorded against a relatively strong continuum, e.g. in the determination of the depolarization factor for a Raman line originating in either a liquid, vapour, or gas. Account is taken of the effects of instrumental light-scatter in both spectrograph and microphotometer. D. R. BARBER

535.33.07 : 535.375.5

4326. A simple arrangement for recording Raman spectra. J. BRANDMÜLLER AND H. MOSER. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 253–6 (1953) *In German.*

Commercial components used include a mercury lamp, Steinheil spectrograph, RCA photomultiplier, d.c. amplifier and pen recorder. A record for CCl_4 shows considerable detail. G. F. LOTHIAN

535.33.07–15

4327. Arrangement for the spectrophotometric study of weak radiations in the near infrared. G. DÉJARDIN, J. JANIN AND M. PEYRON. *C.R. Acad. Sci.* [*Paris*] **238**, 224–6 (*Jan.* 11, 1954) *In French.*

A grating spectrometer is used with an infrared image converter behind which is a photomultiplier coupled to a galvanometer. G. F. LOTHIAN

535.33.07–15

4328. Feed-back resonance amplifier for the infrared spectrometry. I. K. FUKUDA. *J. Phys. Soc. Japan*, **9**, 115–22 (*Jan.–Feb.*, 1954).

An amplifying system employing two galvanometers was successfully used for infrared spectrometry in Firestone's periodic radiometer. The present amplifier, also having two galvanometers, is characterized by the negative feed-back circuit, which connects the photovoltaic-cell secondary-galvanometer circuit with the primary galvanometer so that the latter may oscillate under a resonance condition analogous to the resonance radiometer of Hardy. In this case the primary galvanometer has much higher sensitivity for a signal frequency than in its ordinary use, and then the whole amplifying system can be used free from both zero-drift and noises. A theoretical analysis of the feed-back circuit is given, especially of the motion of the primary galvanometer. A.

535.33.07–15

4329. Feed-back resonance amplifier for the infrared spectrometry. II. K. FUKUDA. *J. Phys. Soc. Japan*, **9**, 123–9 (*Jan.–Feb.*, 1954).

Negative feed-back resonance has been brought about at resonance frequencies of about $0{\cdot}9\ \text{sec}^{-1}$ and $1{\cdot}65\ \text{sec}^{-1}$ according to the numerical computations of Pt I, with experimental corrections, and the circuit constants of the amplifier for various sensitivities at these frequencies have been determined. The amplifier can be worked under resonance at any frequency in a wide range with sensitivity up to the order of 1×10^{-10} V by adjusting the circuit constants. The spectroscopic work with the amplifier have been carried out at the resonance frequency $1{\cdot}65\ \text{sec}^{-1}$ with the sensitivity of 1×10^{-9} V and fine absorption curves have been obtained. A.

535.33.07–31

4330. A photoelectric spectrophotometer for the vacuum ultra-violet region. V. J. HAMMOND AND W. C. PRICE. *J. sci. Instrum.*, **31**, 104–6 (*March*, 1954).

A fluorite prism vacuum spectrophotometer is described in which the effect of scattered light is eliminated by vibrating the Littrow mirror about a horizontal axis while it scans by rotating about a vertical one. The spectral image is alternated on and off the exit slit at a frequency of 10 c/s while the main scattered light from the collimating mirror and the front face of the prism is unaffected. A tuned amplifier is used and the output is free from scatter even when this is several times stronger than the signal. Accurate quantitative work can be carried out with the instrument down to 1500 Å. A.

535.331 : 539.153.4

4331. On the doublet splitting of alkali terms. H. WAGENBRETH. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 285–9 (1953) *In German.*

Using Hartree–Fock eigenfunctions, the doublet splitting of some terms (Na: $4p$; Si^{3+}: $3d$ and $4f$; Ca^{+}: $4p$ and $3d$) is calculated, including contributions from exchange terms. G. FIELD

535.337 : 537.52

4332. The effect of forced transitions and strong continuous emission on the line contour in an inhomogeneous layer. H. BARTELS. *Z. Phys.*, **136**, *No.* 4, 411–40 (1953) *In German.*

A detailed theoretical investigation of absorption effects, emitted spectral line intensities and line shapes from inhomogeneous emitters, such as arc discharges. The effect of continuous background radiation is also considered. J. D. CRAGGS

535.338 : 523.671

Conditions of emission and origin of the 4050 Å group of cometary nuclei. *See Abstr.* 4111

535.338 : 523.872

4333. Experimental afterglows with Balmer decrements relevant to astronomical spectra. M. JOHNSON. *Monthly Not. Roy. Astron. Soc.*, **113**, *No.* 4, 468–76 (1953).

The electron-capture form of Balmer decrement expected in some astronomical spectra cannot be isolated by ordinary laboratory use of fast electrons; the afterglow of a low-voltage high-current radio-frequency ring discharge was therefore examined sufficiently far away from glass walls. Electron multiplier measurement was used, with calibration to absolute intensities, and precautions were taken to obtain the afterglow free from survivals of applied voltage. Pure hydrogen and hydrogen–neon and hydrogen–helium mixtures were investigated. The portions of the decrement resembling a Boltzmann distribution of excitation were distinguished from those which suggest a recombination law, and divergences from either were examined for self-absorption, overpopulation of low energy states, radiationless de-excitation of higher states, etc., in view of likely distortions of astronomical Balmer decrement, notably in red stars, Be stars, and the "Balmer progression" of peculiar stars. A.

535.338 : 539.153

Relations between the low atomic configurations in the long periods. *See Abstr.* 4852

535.338–31 : 535.343–31

4334. A note on the ultra-violet band spectra of CCl and SiCl. R. F. BARROW, G. DRUMMOND AND S. WALKER. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 186–7 (*Feb.*, 1954).

A new band-system with $\nu_{0,0} = 42\,220\ cm^{-1}$ was observed in discharges of low current density through CCl_4 vapour. The $B - X$ system of SiCl was observed in thermal emission and in absorption from the pyrolysis of $SiCl_4$. R. F. BARROW

535.338.1

4335. Low even configurations of the first spectrum of molybdenum (Mo I). R. E. TREES AND M. M. HARVEY. *J. Res. Nat. Bur. Stand.*, **49**, 397–(*Dec.*, 1952).

The analysis of the first spectrum of molybden has been extended by the classification of appr mately 3000 additional lines arising from comb tions including 44 new even levels and 190 new levels that have been located. The identificatio those levels that belong to the three low even c figurations, $4d^4 5s^2$, $4d^5 5s$, and $4d^6$, is given. S unpublished levels found earlier by C. C. Kiess included. Assignment of the terms to the three even configurations has been aided by a theoret calculation. Over-all agreement is very good, indicated by a mean deviation of $\pm 168\ cm^{-1}$ betw theory and experiment. The calculation is presen in a simplified and detailed form, which may hel applying the theory to future analyses. The theoret calculation assumes *LS*-coupling and takes i account the electrostatic interaction between the t configurations. Excellent confirmation of the the of configuration interaction is obtained because interaction is very strong in Mo I. Difficulties assigning a term to a configuration are discussed a tentatively resolved by the use of the calculation. the $3d^5 4s$ configuration of Fe III, Trees has sho that polarization can be accounted for by an empir correction proportional to $L(L+1)$. The ap cability of this correction in the $4d^5 5s$ configurat of Mo I is demonstrated. The correction is o about half as important in Mo I as it is in Fe III, that Mo I is not well suited for a detailed stud polarization effects. However, the agreement obtai is some confirmation of Racah's assumption t polarization can be treated linearly. Magn interactions are considered briefly in an effort explain disagreements between theory and experime and to illustrate additional difficulties that arise the assignment of term designations.

535.33

4336. The sixth series in the spectrum of aton hydrogen. C. J. HUMPHREYS. *J. Res. Nat. B Stand.*, **50**, 1–6 (*Jan.*, 1953).

The first member of the sixth series ($6h^2H^0 - 7$ in the spectrum of atomic hydrogen has been observ at 12·37 μ, in agreement with the predicted positi Other newly observed lines include the second li of the Pfund series and the third, fourth and fi lines of the Brackett series. The source was a wat cooled discharge tube drawing 640 mA at 5000 The tube was fitted with a KBr lens, which serv also as a window for end-on observation. A atomic-hydrogen discharge was maintained admitting water vapour through a Hopfield leak a pumping continuously. A conventional dispersi and recording system was used, consisting of Perkin–Elmer model-12 spectrometer with a d breaker amplifier and Speedomax recorder. Relativ intensity measurements are included.

535.338

4337. An intersystem transition in the first spectru of beryllium. W. R. BOZMAN, C. H. CORLISS, W. MEGGERS AND R. E. TREES. *J. Res. Nat. Bur. Stan* **50**, 131–2 (*March*, 1953).

The intersystem line from the transition $2s^2\ ^1S_0$ – $2s2p\ ^3P_1^0$ has been observed in the first spectrum

/llium. Wavelength measurements give 3·538 ± 0·002 Å, which agrees with the predicted ue of 4548·29 ± 0·4 Å. The energy of the $^3P_1^0$ l is thus determined to be 21 978·92 ± 0·01 K ve the ground state, and the value x to be added ll of the triplet terms of Be I tabulated in "Atomic rgy Levels" [Abstr. 7202 (1949)] is −1·18 K. nsity measurements show that the intensity ratio the singlet resonance line Be I 2348·61 Å, to the rsystem line is about 3×10^7. A.

535.338.3–15

8. Extension of the first spectrum of rhodium I). R. J. MURPHY. *J. Res. Nat. Bur. Stand.*, **49**, –5 (*Dec.*, 1952).

The arc spectrum of rhodium was investigated otographically in the region 6300 to 12 000 Å. e spectrum was excited in conventional direct- rent arcs and photographed on infrared sensitive ulsions with the aid of concave diffraction gratings. velengths have been measured for 238 Rh I lines, luding 90 new lines, of which 53 have been classified. o new even levels have been added to the list of own term values; these two new levels account for of the 53 newly classified Rh I lines. A.

535.338.33

39. The extraction [Entzerrung] of spectral line files by use of Voigt functions. G. ELSTE. *Z. trophys.*, **33**, *No.* 1, 39–73 (1953) *In German.*

The intensity distribution in spectral lines is repre- ed in terms of functions of the form $f(v; \beta_1, \beta_2) = \int f_1(v - x) f_2(x) dx$, where $f_1(x)$ is the dispersion nction $(\beta_1/\pi)(\beta_1^2 + x^2)^{-1}$ and $f_2(x)$ is a Gaussian nction of variance β_2^2. The use of the functions correcting for instrumental distortions of line files is explained, and numerical tables are com- ted for use in such applications. R. A. NEWING

535.338.332

40. Hyperfine structure of the spectrum of Pr II. MURAKAWA AND S. SUWA. *J. Phys. Soc. Japan*, **9**, –6 (*Jan.–Feb.*, 1954).

Analysis of the hyperfine structure of the term $^3(^4I)6s$ of Pr II resulted $\alpha(6s) = 0{\cdot}426\ \text{cm}^{-1}$, $\alpha_4 f = 0227\ \text{cm}^{-1}$. From the value of $\alpha(6s)$ the nuclear gnetic moment of Pr was deduced to be $\mu =$ 4·0 n.m., in agreement with the value given in the erature. From the value of α_{4f} the screening con- nt σ of the $4f$ electron was deduced to be 32·9. e quadrupole moment of Pr was found to be $= (0{\cdot}0 \pm 0{\cdot}2) \times 10^{-24}\ \text{cm}^2$. This is in agreement th the value $Q = -0{\cdot}05 \times 10^{-24}\ \text{cm}^2$ calculated m the data published by Lew regarding the hyper- e structure of the ground term of Pr I. A.

535.338.332 : 539.152.2

41. Hyperfine structures in the iridium *I*-spectrum d the nuclear moments of the stable iridium isotopes. . V. SIEMENS. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 6–57 (1953) *In German.*

Using a Fabry–Perot interferometer the region 00–6300 Å was searched for h.f. structure. Forty ch lines were resolved of which 33 were photo- etered. $I = 3/2$ for both Ir_{77}^{193} and Ir_{77}^{191}. The agnetic and quadrupole moments are $\mu_{193}/\mu_{191} = 0 \pm 0{\cdot}1$, $Q_{193}/Q_{191} = 1{\cdot}0 \pm 0{\cdot}3$; $\mu_{193} = +(0{\cdot}2 \pm 0{\cdot}1)$ n.m., $Q = +(1{\cdot}5 \pm 1) \times 10^{-24}\text{cm}^2$. The isotope-shift constant is $\beta C = (130 \pm 30) \times 10^{-3}\ \text{cm}^{-1}$, consistent with values for neighbouring elements.

W. J. SWIATECKI

535.338.333

4342. The isotope shift in the spectrum of argon. H. MEYER. *Helv. phys. Acta*, **26**, *No.* 7–8, 811–20 (1953) *In German.*

Fabry–Perot etalons were used to investigate the isotope shift of A^{36}, A^{38} and A^{40} in the emission spectra A I and A II, using separated isotopes. Typical interference spectra are shown, and the results are presented in tabular form. The measurements for the A I spectra are in agreement with those of Kopfermann. The shifts for the A II spectra are discussed. J. HUGHES

535.338.333

4343. Isotope shifts in the infrared spectrum of HgI. G. R. FOWLES. Letter in *J. Opt. Soc. Amer.*, **44**, 85 (*Jan.*, 1954).

535.338.334

4344. Self pressure-broadening of the sodium resonance lines. J. TOMISER. *Acta phys. Austriaca*, **8**, *No.* 2, 198–206 (1953) *In German.*

Light from a W lamp was passed through Na vapour and the *D*-lines photographed in absorption with a grating spectrograph. The Na pressure in the cell containing it was determined from the oven temp. by $\log p = -a/T + b$. The line widths at half max. intensity were determined by micro-photometry of the plates. At 300°c the pressure was 0·013 mm of Hg, the line widths 0·108 Å for the 5890 Å line and 0·095 Å for the 5896 Å. At 415°c the values were 0·503 mm, 1·565 Å, 1·075 Å respectively. The increases of width were proportional to pressure, and also to density of the Na vapour.

S. T. HENDERSON

535.338.334

4345. Theory of fine structure pressure broadening of spectral lines. M. TAKEO AND S.-Y. CH'EN. *Phys. Rev.*, **93**, 420–4 (*Feb.* 1, 1954).

The difference of pressure broadenings and shifts of the doublet components of the principal series lines of alkalis is treated in an approximate manner. Applying the perturbation method and the Franck–Condon principle to the Michels, deBoer and Bijl model of compressed atoms in the doublet P states, it is shown that the doublet separation becomes smaller with increasing pressure at rather low pressure. Consequently, the shift of the $^2P_{\frac{3}{2}}$ must be smaller than that of the $^2P_{\frac{1}{2}}$ component of the principal series. The attractive forces are recalculated with the inclusion of the quadrupole moment for the $^2P_{\frac{3}{2}}$ state. This consideration requires the splitting of the state according to the magnetic quantum numbers so that the $^2P_{\frac{3}{2}}$ component will be 1·12 times larger in half-width than $^2P_{\frac{1}{2}}$ in the approximation of the collision theory. This result is in good agreement with experimental values. A.

535.338.4

4346. The emission spectrum of aluminium monofluoride. II. S. M. NAUDÉ AND T. J. HUGO. *Canad. J. Phys.* **32**, 246–58 (*March*, 1954).

For Pt I, see Abstr. 4698 (1953). Four new band systems of the emission spectrum of AlF are described,

viz. the $D^1\Delta - A^1\Pi$ system in the yellow-green, the $F^1\Pi - A^1\Pi$ and $G^1\Sigma = A^1\Pi$ systems in the blue, and the $F^1\Pi - B^1\Sigma$ system in the infrared spectral region. A vibrational as well as a rotational analysis of the $D^1\Delta - A^1\Pi$ system is reported. The rotational analyses of the other systems, each of which consists of a single band, are described. A.

535.338.4 : 539.132

4347. Spectroscopic data concerning diatomic molecules. [Données spectroscopiques concernant les molécules diatomiques.] R. F. Barrow, A. D. Caunt, A. R. Downie, R. Herman, E. Huldt, A. McKellar, E. Miescher, B. Rosen and K. Wieland. *Paris: Hermann et Cie* (1951) 361 *pp.* [Tables de constantes et données numériques. Constantes selectionnées, 4] *In French.*

The following are given for each molecule: Methods of production of the spectra; Systems and groups of bands with collected table showing transitions, favourable sources, limits of observation, sense of degradation most characteristic bands and detailed tables; Molecular constants for each state; Perturbation data; Potential energy curves; Photochemical behaviour (in some cases); Bibliography. The bibliography for the whole volume, practically complete up to July, 1951, consists of 2625 references [see also Abstr. 3992 (1953)].

535.338.4 : 539.132

Relative transition probabilities in band systems of diatomic molecules. *See Abstr.* 4787

535.338.4 : 539.133

4348. The *E–X* band system of SiS in emission and the dissociation energy of SiS. S. J. Q. Robinson and R. F. Barrow. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 95–6 (*Jan.*, 1954).

New observations lead to more reliable vibrational term-values for the E state, from which D_0''(SiS) is found to be $147._4 \pm 3{\cdot}0$ kcal. R. F. Barrow

535.338.4 : 551.594.51

4349. Excitation conditions for the infra-red auroral bands of ionised nitrogen. D. T. Stewart, P. W. F. Gribbon and K. G. Emeléus. Note in *Proc. Phys. Soc.* [*London*] *A*, **67**, 188–9 (*Feb.*, 1954).

The mechanism of production from a number of sources of the near infrared $A^2\Pi - x^2\Sigma_g^+$ bands of N_2^+, first observed in the auroral spectrum by Meinel (1950), is discussed, the assumption being made that the main process involved is electron collision with neutral N_2 molecules to produce N_2^+ ions. The most controllable laboratory source consists in a collision-chamber outside of which is placed a thermionic electron-source. Meinel bands appear at exciting voltages >20 eV, and if all traces of 0_2 are eliminated the complete series of auroral bands recorded by Meinel (1951) appears with approximately similar relative intensities. Emission of Meinel, and negative bands is restricted to the electron path in the chamber; whereas the First Positive bands are emitted for a considerable distance outside the electron beam. D. R. Barber

535.342

4350. Method for resolving spectral curves more sharply. L. Akobjanoff. Letter in *J. Opt. Soc. Amer.*, **44**, 85–6 (*Jan.*, 1954).

Absorption peaks can be located more precisely by plotting $A = I(1/T - 1)$ instead of I/I_0 ag wavelength, where T is the transmission throu 1 cm layer. With a Beckmann spectrophotomet can be read directly if I is arranged to be cons for each observation in a series, which may inc the whole spectrum or a section including one p Curves are given to show the very sharp ma obtained. S. T. Hendel

53

4351. Singlet-triplet absorption bands in s halogen substituted aromatic compounds. D. McClure, N. W. Blake and P. L. Hanst. *J. c Phys.*, **22**, 255–8 (*Feb.*, 1954).

Singlet-triplet absorption bands are reported f number of halogen benzenes and naphthalenes. C bining the results with other data, the rates of ra tionless triplet to ground state transitions are fo The effect of the atomic number of a substit halogen atom on the absorption strength is show agree with a simple theory. It is also shown that spectroscopic moments of substituents do not vectorially for singlet-triplet transitions.

535.343 : 539

4352. The electronic spectra of cata-conde hydrocarbons. W. Moffitt. *J. chem. Phys.*, 320–33 (*Feb.*, 1954).

It is shown how the main features of the spectr cata-condensed hydrocarbons may be explained on basis of a very simple model. This, so-called p meter model was used, in its free-electron variant Platt in order to classify the spectra. In this not more quantitative version is formulated which ena calculations to be made; it may be considered as approximation either to an antisymmetrized molec orbital treatment or to the method of atoms molecules.

535.343

4353. The infrared spectra of monochlorogerm and monochlorogermane-d_3. R. C. Lord and C. Steese. *J. chem. Phys.*, **22**, 542–6 (*March*, 1954).

Infrared absorption spectra of GeH_3Cl and GeD have been observed and the fundamentals located 2121·2, 847·7, 422·6 cm^{-1} (parallel) and 212 874·6, 604·1 cm^{-1} (perpendicular) in GeH_3Cl, and 1522, 614, 421 cm^{-1} (parallel) and 1530, 630, 434 cm (perpendicular) in GeD_3Cl. Analysis of the rotatio structure of the perpendicular bands in GeH_3Cl le to these values of the rotational constants: 2·603 cm^{-1}; ζ_4, −0·059; ζ_5, −0·124; ζ_6, +0·2 Agreement with microwave A'' is satisfacto Thermodynamic quantities are computed for GeH and GeD_3Cl.

535.343–15 : 535.37

4354. Substituted methanes. XVIII. Vibratio spectra of $C^{13}H_3I$. R. B. Bernstein, F. F. Cleveland and F. L. Voelz. *J. chem. Phys.*, **22**, 193–7 (*Fe* 1954).

Raman (liquid) and infrared (liquid and gas, w KBr and NaCl prisms) spectra were obtained [for XVII, see Abstr. 1167 (1954)] for two mixtures $C^{13}H_3I$ (9·3 and 61 atom %) and $C^{12}H_3I$, and fr these vibrational spectrum of $C^{13}H_3I$ has been deduc In the Raman spectrum, only $\nu_3(a_1)$—the C–I stret ing frequency—could be resolved from the $C^{12}H$

es; the isotopic shift was $-17{\cdot}7 \pm 0{\cdot}5\ cm^{-1}$. In infrared spectrum (gas), five isotopic shifts were tained; they were: $\nu_1(a_1) - 10 \pm 3$, $\nu_2(a_1) - 5{\cdot}5 \pm$ 0), $\nu_3(a_1) - 16{\cdot}1 \pm 1{\cdot}0$, $\nu_5(e) - 4{\cdot}4 \pm 0{\cdot}8$ and $e) - 3{\cdot}7 \pm 0{\cdot}3\ cm^{-1}$. For the remaining fundaental, $\nu_4(e)$, the shift was obtained by use of the dlich–Teller product rule; the value was $-9{\cdot}4 \pm$ $3\ cm^{-1}$. Analysis of the perpendicular bands lded, with the aid of microwave data, values of e rotational constants, Coriolis interaction conants and band origins for the $\nu_6(e)$, $\nu_5(e)$ and $\nu_4(e)$ nds of $C^{12}H_3I$ and $C^{13}H_3I$, though the values for e $\nu_4(e)$ band of $C^{13}H_3I$ are incomplete and are only timated values since the sub-bands were not resolved this case. A.

535.343.2/.3–15

355. Modification of the infrared absorption spectra saturated aliphatic acids which accompanies the ssage from the liquid to the solid state. C. Rigaux. *.R. Acad. Sci.* [*Paris*] **238**, 63–5 (*Jan.* 4, 1954) *In ench.*

It is supposed that the bands for the liquid are ss sharp because of the existence in the liquid, but ot in the solid, of several isomeric configurations ound the C–C axis. Curves are given for the C_8 id for 700–1800 cm^{-1}. G. F. LOTHIAN

535.343.2/.3–15

356. On the multiplicity of the infrared absorption nds of aliphatic alcohols and acids provoked by ssage from the solid to the liquid state. M. Neuilly. *.R. Acad. Sci.* [*Paris*] **238**, 65–7 (*Jan.* 4, 1954) *In ench.*

The acids C_{10} to C_{27} show more and sharper bands the solid state for the same reasons as given in the eceding abstract. G. F. LOTHIAN

535.343.2

357. Absorption spectrum of solid oxygen between 000 and 1500 Å. J. Romand and J. Granier-Layence. Letter in *J. Phys. Radium*, **15**, 62–3 *an.*, 1954) *In French.*

Absorption is increasing with decreasing wavelength roughout the range; the considerable difference om gaseous O_2 is attributed to the presence of O_4 olecules. G. F. LOTHIAN

535.343.2

358. On the series of absorption lines of Cu_2O lms at low temperatures. S. Nikitine, G. Perny and I. Sieskind. *C.R. Acad. Sci.* [*Paris*] **238**, 67–9 *an.* 4, 1954) *In French.*

Three series of absorption lines were observed from ry thin microcrystalline Cu_2O films (20 to 70 μ) at e temperature of liquid nitrogen. The position of ese lines changes with temperature. A green series owed three clear lines which could be grouped in a ydrogenlike series. A yellow series showed similar gularities: four lines could be grouped in such a ries. The third group, which was observed in the range region, may also contain such a series although is is less clear. It contains a region of minimum sorption, which might be an emission line, at 080 Å. It is suggested that the green series might be fundamental exciton series, and the other two brational superpositions of the first. A. J. TAYLOR

535.343.2–12

4359. On the existence of absorption bands in the Hertzian spectrum for the monatomic semiconductors (boron, selenium). J. Meinnel. Letter in *J. Phys. Radium*, **15**, 124–5 (*Feb.*, 1954) *In French.*

Measurements of ε'' on the powders in a cylindrical condenser from 88–300°K and 100 c/s to 400 kc/s show various loss peaks for B and metallic Se, which vary somewhat with sample. The activation energies are in the range 0·12–0·60 eV. D. H. WHIFFEN

535.343.2–14

4360. New absorption lines of crystals in submicrowave region. S. Kojima, K. Tsukada, S. Ogawa and A. Shimauchi. Letter in *Phys. Rev.*, **92**, 1571 (*Dec.* 15, 1953).

In many compounds including AgI, ZnS, $Ba(ClO_3)_2$, NaCl, quartz and Rochelle salt sets of absorption lines were observed with a super-regenerative oscillator in the range 3 to 500 Mc/s. In general they were very sharp, were spaced at about 10 kc/s intervals, had a temperature coefficient $\nu^{-1}d\nu/dt$ of -3×10^4/°c and appeared to be located in small regions of the crystals. They were distinguished from quadrupole resonance by being strongest with the sample in the electric field of the measuring frequency and by having no observable Zeeman effect. D. H. WHIFFEN

535.343.2–15

4361. Infrared absorption spectra of complex cobalt salts. D. G. Hill and A. F. Rosenberg. Letter in *J. chem. Phys.*, **22**, 148 (*Jan.*, 1954).

Using dry powders of cobalt (III) ammines, in the near infrared, two strong bands in the 820 cm^{-1} and 1300 cm^{-1} were found for all salts, due to octahedral vibration of the cation. For increasing anion size the 820 cm^{-1} peak shifts to a longer wavelength.

C. TURNER

535.343.2–15

4362. Infrared lattice absorption bands in germanium, silicon, and diamond. R. J. Collins and H. Y. Fan. *Phys. Rev.*, **93**, 674–8 (*Feb.* 15, 1954).

Infrared absorption bands characteristic of the crystal lattice were investigated for germanium and silicon. The absorption was found to be insensitive to lattice imperfections due to impurities ($\sim10^{18}\ cm^{-3}$) and due to disorders ($\sim10^{19}\ cm^{-3}$) produced by nucleon irradiation. It did vary with temperatures in the same way as the calculated mean-square displacement of the atoms. Variations of absorption with temperature were also studied for two specimens of type I diamond. The bands characteristic of type II diamonds showed similar temperature dependence, whereas the long-wavelength bands were temperature insensitive. It appears that the observed absorption in germanium and silicon corresponds to the absorption characteristic of type II diamond and is made possible by the thermal vibration of the atoms. The long-wavelength bands in type I diamonds may be due to impurities. A.

535.343.2–15 : 537.312.5 : 537.311.33

Infrared absorption, photoconductivity, and impurity states in germanium. *See Abstr.* 4530

535.343.2–15 : 541.62

4363. The vibrational spectra and structure of solid hydroxylamine and deutero-hydroxylamine. R. E. NIGHTINGALE AND E. L. WAGNER. *J. chem. Phys.*, **22**, 203–8 (*Feb.*, 1954).

The infrared spectra of thin films of H_2NOH and D_2NOD were obtained at −78° and −190°c in the region 4000–500 cm^{-1}. Two distinct types of spectra resulted depending on whether the films were formed at −78° or at −190°c. The spectra obtained when the films were formed at −190°c were characterized by broad overlapping bands; those formed at −78°c gave much narrower bands, some of them splitting into two or more distinct components. The latter type spectrum is representative of the stable crystalline form at low temperature. This spectrum could not be correlated with the amine oxide form of hydroxylamine, $NH_3 \rightarrow O$. Satisfactory vibrational assignments could, however, be made for the model with symmetry of the point group C_s, H_2NOH. If *cis-* and *trans-*rotational isomers coexist in the solid, they must possess very nearly the same potential energy or at least a high potential barrier between them. The O–H stretching vibration in the solid is found at a very low frequency, 2867 cm^{-1}, indicating a very strong hydrogen-type bond with energy of about 13 kcal per mole. A.

535.343.2–15 : 548.7

4364. The infrared spectra and structure of LiOH, $LiOH.H_2O$ and the deuterium species. Remark on fundamental frequency of OH^-. L. H. JONES. *J. chem. Phys.*, **22**, 217–19 (*Feb.*, 1954).

The infrared spectrum of a thin path of solid LiOH and $LiOH.H_2O$ (undeuterated, partially deuterated and completely deuterated) has been observed. The spectra indicate that both hydrogens from each water molecule are used to form strong hydrogen bonds in the hydrate. The results serve to substantiate the crystal structures previously determined by X-ray diffraction. For LiOH the absorption maximum occurs at 3678 ± 1 cm^{-1}; the fundamental frequency of OH^- in LiOH is 3839 ± 10 cm^{-1}. The spectrum of LiOH.HDO exhibits an anomaly in the bending frequency of HDO. A.

535.343.3–14

4365. Absorption of u.h.f. radio waves in the range 250–920 Mc/s by substituted benzenes. III. D. K. GHOSH. *Indian J. Phys.*, **27**, 285–93 (*June*, 1953).

The absorption in chlorobenzene, bromobenzene, *o*-xylene and *m*-xylene at room and lower temperatures was investigated by an optical method, using a G.R. 1209 A oscillator as the source of radio waves. In the case of chlorobenzene a peak was observed at 820 Mc/s at room temperature and this is observed to shift to 580 Mc/s at 0°c. The peak is found to be due to a dimer. In the case of bromobenzene the peak at room temperature is beyond 920 Mc/s, but it is at 880 Mc/s at 0°c. The peak is due to a monomer. Indication of a peak below 250 Mc/s at 0°c due to dimers has also been observed. In the case of *o*-xylene no absorption was observed at room temperature, but the liquid showed an absorption peak at 570 Mc/s at 0°c, which shifts to 500 Mc/s at −20°c. This peak is due to dimers. In the case of *m*-xylene at 0°c no absorption was observed, but at −30°c an absorption peak at 820 Mc/s was obser This peak is also due to dimers. It is concluded f these results that with the lowering of temperature the liquids mentioned above associated groups molecules, each group containing two molecules, formed and the number of such groups increases v further lowering of temperature. [See also Abstr. 7 (1950).]

535.343.3

4366. Infrared absorption spectrum of liquid w in the 3200 to 3600 cm^{-1} region. S. N. ANDREEV T. G. BALICHEVA. *Dokl. Akad. Nauk SSSR*, *No.* 2, 149–51 (1953) *In Russian.* English translat *U.S. National Sci. Found. NSF-tr-66.*

The results obtained are represented graphica and discussed with particular reference to previou recorded data. G. I. W. LLEWE

535.343.3

4367. Study of infrared absorption curves of carbonyl group of ketones. E. GRAY AND C. MANC *J. Phys. Radium*, **15**, 9–12 (*Jan.*, 1954) *In French.*

It has been suggested previously that the 1700 cm carbonyl band, which shows a slight shift in Ram spectra with respect to infrared, is in fact the envelo of several bands. In order to investigate this, infra spectra of various ketones were measured accurat in this region. It was found that this band is in f a system of three vibration-rotation bands. T absorption frequencies are independent of the ph of the ketone, but the intensities are not: the low frequency band has relatively the strongest absorpt in solid ketones; in the liquid compounds the n band is strongest, and in a solution in a neut solvent the highest frequency band shows the strong absorption. A. J. TAYL

535.343.3–

4368. Wavelength shifts in the near ultravio spectra of fluorinated benzenes. H. SPONER. *J. che Phys.*, **22**, 234–5 (*Feb.*, 1954).

Results on wavelength shifts of the 0, 0 bands in t near ultraviolet absorption spectra of a number fluorinated benzenes are presented, and a brief disc sion in terms of the inductive effect and the migrati effect is added.

535.343.4

4369. Absolute intensity of water-vapor absorpti at microwave frequencies. T. F. ROGERS. Letter *Phys. Rev.*, **93**, 248–9 (*Jan.* 1, 1954).

Consideration of small terms neglected in t earlier theoretical treatment [Abstr. 1823 (194 show that these do not account for the discrepan with experimental values and the conclusion that t van Vleck–Weisskopf formula is inadequate in the f wings of the absorption lines remains. D. H. WHIFF

535.343.4–

4370. Microwave spectrum of $N^{14}O^{16}$. J. GALLAGHER, F. D. BEDARD AND C. M. JOHNSO *Phys. Rev.*, **93**, 729–33 (*Feb.* 15, 1954).

The $J = 1/2 \rightarrow 3/2 (v = 0)$ rotational transition the $^2\pi_{1/2}$ state of $N^{14}O^{16}$ has been measured. Th transition occurs at 150 372·30 Mc/s and is split in two groups of five lines due to V-type doubling a a large magnetic hyperfine interaction. The value

is found to be $1{\cdot}69510\ cm^{-1}$ and $r_0 = 1{\cdot}1539$ Å. The Λ-doubling constant p is determined as 1·2 Mc/s, and a spin of 1 is again confirmed for ^{1}. A preliminary analysis of the magnetic hyperfine ucture is given, based on the interaction Hamilian $aI_{z'}L_{z'} + b\mathbf{I}\cdot\mathbf{S} + cI_{z'}S_{z'}$, where a, b and c constants. A.

535.343.4–14

71. Microwave spectrum of O_2. M. Mizushima D R. M. Hill. *Phys. Rev.*, **93**, 745–8 (*Feb.* 15, 54).

Twenty-four lines of the microwave spectrum of ygen molecule have been carefully measured. The eoretical origin of this spectrum is re-examined and e effect of centrifugal distortion is taken into account. he agreement between theory and experiment is tisfactory. It is pointed out that this spectrum is not itable to determine the velocity of light. A.

535.343.4–14

372. The microwave spectrum of hydrogen peroxide. T. Massey and D. R. Bianco. *J. chem. Phys.*, **22**, 42–8 (*March*, 1954).

Nine absorption lines of H_2O_2 and some one undred absorption lines of D_2O_2 and HDO_2 have een observed in the microwave frequency region sing a flow system for sampling to overcome the ecomposition of the peroxide at low vapour pressure. n analysis of the microwave spectrum of H_2O_2, sing a symmetric top approximation, reveals that it necessary to invoke hindered internal rotation to xplain the experimental data. Using a sinusoidal pproximation for the hindering potential yields a arrier height of about $113\ cm^{-1}$. From the Stark ffect calculations, a value of dipole moment of ·26 Debye units is obtained. Some limiting conditions on the values of the molecular parameters are iscussed. A.

535.343.4–14

373. The microwave spectrum of vinyl cyanide. V. S. Wilcox, J. H. Goldstein and J. W. Simmons. *. chem. Phys.*, **22**, 516–18 (*March*, 1954).

The rotational spectrum of the slightly asymmetric op, vinyl cyanide, has been investigated in a microwave spectrograph employing Stark effect modulation n a direct absorption cell. The rotational constants $a = 49\,076{\cdot}2$ Mc/s, $b = 4971{\cdot}33$ and $c = 4514{\cdot}05$ were computed from the observed frequencies f the $J = 2 \rightarrow 3$ transitions. From measurements f the Stark effect, the components of the dipole oment were found to be $\mu_a = 3{\cdot}68D$, $\mu_b = 1{\cdot}25$, $\mu = 3{\cdot}89$. Partial resolution of the hyperfine structure of certain lines gave the value $-3{\cdot}0$ Mc/s for he χ_{aa} component of quadrupole coupling. A.

535.343.4–14

4374. Zeeman effect and line breadth studies of the microwave lines of oxygen. R. M. Hill and W. Gordy. *Phys. Rev.*, **93**, 1019–21 (*March* 1, 1954).

Measurements made at 90°K and at 300°K on the O_2 line breadths show that the line breadth parameter, $\Delta\nu$, varies as T^{-x}, with x ranging in value from 0·76 for the 9_ line to 0·90 for the 1_ line. The type of variation of x rotational quantum number N indicates that both rotational resonance and quadrupole moment interactions are important factors in determining the line breadths. The Zeeman splittings observed for the 1_-, the 1_+ and the 3_- lines are in good agreement with the splitting predicted from first-order perturbation theory. A.

535.343.4–14 : 539.133

4375. The microwave spectra, structure, and dipole moment of stable pentaborane. H. J. Hrostowski and R. J. Myers. *J. chem. Phys.*, **22**, 262–5 (*Feb.*, 1954).

The microwave spectra of several of the naturally occurring boron isotopic species of B_5H_9 and B_5D_9 have been observed. These data show that stable pentaborane consists of a tetragonal pyramid of boron atoms and has either C_4 or C_{4v} symmetry. The boron-boron distances are $B_1 - B_2 = 1{\cdot}687 \pm 0{\cdot}005$ and $B_2 - B_2 = 1{\cdot}800 \pm 0{\cdot}003$ Å. If C_{4v} symmetry and $B_1 - H_1$ distances equal to 1·22 Å are assumed, the following boron-hydrogen parameters are obtained: $B_2 - H_3 = 1{\cdot}35 \pm 0{\cdot}02$ Å, $\angle B_1 - B_2 - H_2 = 136°\ 10' \pm 30'$ and $\angle B_1B_2B_2 - B_2B_2H_3 = 196 \pm 2°$. Dipole moment values of $2{\cdot}13 \pm 0{\cdot}04$ and $2{\cdot}16 \pm 0{\cdot}04$ Debye units were measured for B_5H_9 and B_5D_9 respectively. A.

535.343.4–15

4376. Perturbation of the fundamental infrared bands of HCl and CO by various gases compressed up to 1000 atm. R. Coulon, L. Galatry, B. Oksengorn, S. Robin and B. Vodar. Letter in *J. Phys. Radium*, **15**, 58–9 (*Jan.*, 1954) *In French.*

See also Abstr. 6637 (1953). The influence of compressed He, H_2 and O_2 on the $3000\ cm^{-1}$ band of HCl and that of N_2 and A on the $2100\ cm^{-1}$ CO band were investigated. With He the perturbation was weak compared with that caused by N_2, and the rotational structure was still visible in the P branch at considerable pressures. The effect grew stronger in the series He, H_2, A, O_2, N_2. With HCl an increase in intensity was observed in the band centre, which could be attributed to the moment induced by the field caused by the alien molecules, but this does not explain the very different changes in intensity caused by O_2 and N_2. For CO the shape of the band varies little at pressures above 20 atm. The changes in intensity are smaller here than for HCl, which is to be expected as the dipole moment is smaller. A. J. TAYLOR

535.343.4–15 : 535.375.55

4377. The infrared and Raman spectra of carbon suboxide. H. D. Rix. *J. chem. Phys.*, **22**, 429–33 (*March*, 1954).

The infrared spectrum of C_3O_2 has been studied in the vapour phase from 2·2 to 20 μ with a Perkin–Elmer double-pass spectrometer, and the Raman spectrum has been photographed in the liquid phase. A comparison of the Raman with the infrared spectrum shows definitely that the molecule has a centre of symmetry as is required for the linear structure commonly assumed. However, the infrared spectrum cannot be explained on the assumption of a linear model; the envelopes of the principal absorption bands as well as those of the weaker combination bands have the wrong shape. It appears rather that the oxygen atoms are bent out of line with the carbons in a plane zig-zag configuration. From the rotational structure of one of the combination bands the

O—C—C angle is computed to be approximately 158°. A.

535.343.4–15 : 535.375.56

4378. The infrared and Raman spectra of formaldehyde-d_1 vapor. D. W. Davidson, B. P. Stoicheff and H. J. Bernstein. *J. chem. Phys.*, **22**, 289–94 (*Feb.*, 1954).

The infrared spectrum of HDCO vapour were investigated in the region $2{\cdot}5\ \mu - 25\ \mu$ and all six fundamentals were observed. Four of the fundamentals were also observed in the Raman spectrum of the vapour. The perpendicular component of an hybrid band at $3{\cdot}5\ \mu$ and the pure rotational Raman spectrum were resolved and analysed. The rotational constant $(A - \bar{B})$ for the symmetric top approximation was found to be $5{\cdot}47 \pm 0{\cdot}03\ cm^{-1}$. This value, combined with the rotational constants of H_2CO obtained by Dieke and Kistiakowsky, yields approximate molecular dimensions for the ground state of formaldehyde. A.

535.343.4–15 : 539.132

4379. Vibration-rotation bands and molecular constants of carbonyl sulphide. H. J. Callomon and H. W. Thompson. *Proc. Roy. Soc. A*, **222**, 431–43 (*March* 23, 1954).

The vibrational absorption bands of carbonyl sulphide $C^{12}O^{16}S^{33}$ near $5\ \mu$ were examined using very high resolving power. Rotational fine structure has been resolved for the first time; six bands have been studied, including two associated with the isotopic species $C^{13}O^{16}S^{33}$, and a rotational analysis of each has been carried out. Values have been derived for the rotational constants B and D in the different vibrational levels, and these have been compared with the results obtained from the microwave spectrum for the lower states. It has been found that the location of certain bands, and the rotational constants B are affected by Fermi resonance and Coriolis interaction, and estimates of the unperturbed values have been made. A.

535.343.4–15 : 539.132

4380. Vibration-rotation bands of methyl fluoride. J. Pickworth and H. W. Thompson. *Proc. Roy. Soc. A*, **222**, 443–55 (*March* 23, 1954).

The vibration-rotation bands of methyl fluoride between $2{\cdot}5$ and $5\ \mu$ were measured with higher resolution than previously. Three parallel bands have been analysed, providing three independent values for B'', the rotational constant in the ground state. Each of these values is close to that obtained from the microwave spectrum ($0{\cdot}8518\ cm^{-1}$), and some earlier values deduced from infrared bands are shown to be incorrect. A value of $2{\cdot}28 \times 10^{-6}\ cm^{-1}$ has also been obtained for D_J, the centrifugal stretching constant, which is shown to be more satisfactory than that previously deduced from the microwave spectrum. A perpendicular type band has been resolved fairly completely, and it has been possible to measure the P and R lines of the sub-bands in addition to the strong Q branches. An analysis has been made which accounts satisfactorily for most of the lines in the entire band, and this provides the first example of such a complete analysis of a perpendicular band of a symmetrical top molecule. A.

535.343.4–15 : 53

4381. The infrared spectrum and molecular cons of DBr. F. L. Keller and A. H. Nielsen. *J. c Phys.*, **22**, 294–9 (*Feb.*, 1954).

High-dispersion measurements have been mad the first time on the fundamental, first overtone second overtone infrared vibrational bands of Path lengths from 40 cm to 17 m were used pressures ranging from 90 mm to 460 mm. isotopic splitting of the rotation lines was measu and molecular constants determined for both isot species, DBr^{79} and DBr^{81}. The principal const for DBr^{79} are $\omega_e = 1885{\cdot}33\ K$, $x_e\omega_e = 22{\cdot}7$ $y_e\omega_e = -0{\cdot}0106\ K$, $B_e = 4{\cdot}290_8\ K$, $\alpha_e = 0{\cdot}083$ $D_e = 9{\cdot}6_4 \times 10^{-5}\ K$, $\beta = -2{\cdot}_2 \times 10^{-6}\ K$. The p cipal constants for DBr^{81} are $\omega_e = 1884{\cdot}7$ $x_e\omega_e = 22{\cdot}72\ K$, $y_e\omega_e = -0{\cdot}0106\ K$, $B_e = 4{\cdot}$ K, $\alpha_e = 0{\cdot}083_8\ K$, $D_e = 9{\cdot}5_9 \times 10^{-5}\ K$, $\beta =$ $\times 10^{-6}\ K$.

535.343.4–15 : 539

4382. *l*-Type doubling in C_2H_2 and HCN. T. Wiggins, J. N. Shearer, E. R. Shull and D. Rank. *J. chem. Phys.*, **22**, 547–50 (*March*, 1954).

A high-resolution infrared grating spectrometer been used to investigate *l*-type doubling of ene levels of the linear molecules C_2H_2 and HCN. solving power of 145 000 was obtained at 4100 cm which permitted the resolution of the Q branch $\nu_1 + \nu_5^1(\Sigma_g^+ \rightarrow \Pi_u)$ of C_2H_2 to $J'' = 6$. The differe between the $B' - B''$ value determined from the branch and the same quantity obtained from the and R branches of this band yields a value $q = 4{\cdot}72 \times 10^{-3}\ cm^{-1}$. The doublet structure in difference band $01^10 \rightarrow 01^12(\pi \rightarrow \pi)$ of HCN been resolved for $J'' \geqslant 6$ in the R branch and $J'' \geqslant$ in the P branch. This $\pi \rightarrow \pi$ band is treated as t bands with slightly different molecular constan Evaluation of rotational constants shows that differe α values are obtained for the + and − components these π states. The difference in frequency betwe lines of equal J'' in the $000 \rightarrow 002$ and $01^10 \rightarrow 01$ bands is shown to be a quadratic function of J The value obtained for q' was $7{\cdot}68 \times 10^{-3}\ cm^{-1}$.

535.343.4–15 : 539.1

4383. The near infrared spectrum and the inte nuclear distances of nitrous oxide. A. E. Dougl and C. K. Møller. *J. chem. Phys.*, **22**, 275–9 (*Fe* 1954).

The near infrared spectra of $N_2^{14}O^{16}$ and $N^{15}N^{14}O$ have been investigated using a high-resolution grati spectrometer. The α's and hence the B_e values f both isotopic species have been determined. Fro the B_e values, the equilibrium N — N and N — internuclear distances have been found to be $1{\cdot}126$ and $1{\cdot}186$ Å, respectively.

535.343.4–3

4384. The near ultraviolet absorption spectrum *para*-difluorobenzene vapor. C. D. Cooper. *J. che Phys.*, **22**, 503–10 (*March*, 1954).

The vapour spectrum of *p*-difluorobenzene w obtained with a Bausch and Lomb Littrow spectr graph. The band at $36\,843\ cm^{-1}$ is assigned as t 0, 0 band of the $A_g - B_{3u}$ electronic transitio

und-state frequencies of 452, 860 and 1259 cm^{-1} h the corresponding excited state frequencies of 819 and 1250 cm^{-1} are assigned to totally sym- ric vibrations. Also, an 841 cm^{-1} frequency is gned to the ground state of a totally symmetric ation. Many of the bands that are temperature endent are shown to result from a transition that olves a 248 cm^{-1} ground-state vibration. This cm^{-1} frequency is assigned as a β_{1g} fundamental. st of the prominent bands are assigned to progres- as or combinations of the above frequencies. The usually large spectral shift produced by the two *a*-positioned fluorines is discussed. A.

535.345 : 532.623

85. Bubbles in optical glass and the resultant ghtness loss. J. Picht. *Optik*, **10**, *No.* 12, 603–4 53) *In German.*

The system used by Schott for classifying the mber of bubbles found in optical glass is described. is gives two numbers B_z, the average number of bbles per cm^3, and B_p, the average volume occupied bubbles per cm^3. Relationships are derived from nple geometric considerations giving the light lost a lens through the presence of bubbles. R. W. FISH

535.345 : 535.324

86. The influence of the refractive index on the sorption of light by solutions. J. Schuyer. *Recueil av. chim. Pays-Bas*, **72**, 933–49 (*Nov.*, 1953).

Starting from the theory of Onsager–Böttcher a w formula is derived by which the influence of the fractive index on the molar extinction coefficient of solution can be calculated. As this formula is rather mplicated, approximation formulae are given for rtain types of solutions. These formulae prove to e in better agreement with experiment than the rmula of Chako–Kortüm. A.

535.345 : 537.312.5

387. The optical and electrical properties of cad- ium sulphide films. G. Kuwabara. *J. Phys. Soc. apan*, **9**, 97–102 (*Jan.–Feb.*, 1954).

The optical and electrical properties of evaporated dS film were measured. The optical properties are imilar to those of the single crystal, that is, the bsorption edge lies at 2·4 eV; the photosensitivity eaks near the edge; with temperature decrease, the bsorption edge and photosensitivity maximum shift owards shorter wavelength; while the electrical roperties show wide variation from sample to sample nd by heat treatment. The photoresponse shows arge dependence on the temperature and is closely elated to the dark conductivity. By baking in air, he conductivity at room temperature decreases a great deal and the activation energy increases. By baking in a reducing atmosphere, the conductivity, the activation energy and photoresponse almost regain their initial values. In this process, the adsorption or desorption of oxygen on the surfaces of micro- crystals plays an important rôle. The bimolecular recombination argument for the interpretation of spectral sensitivity curves seems inadequate. A.

535.345–15

4388. Transmission of near-infrared energy by some two- and three-component glasses. J. M. Florence, F. W. Glaze and M. H. Black. *J. Res. Nat. Bur. Stand.*, **50**, 187–96 (*April*, 1953).

Most silicate glasses have a region of absorption for radiant energy at wavelengths longer than 2·7 μ. This absorption has been found to be caused by the presence of water and CO_2 in the glass. Means for removing much of this absorption from some glasses have been developed. Also, it has been found that glasses containing lead oxide or barium oxide, or combinations of the two, do not appear to retain as much water as most other glasses. A soda-lead oxide-silica glass and a barium oxide-lead oxide-silica glass with high transmission for near-infrared energy have been developed. A.

535.345–15 : 537.312.5

4389. Infrared optical properties of single crystals of tellurium. J. J. Loferski. *Phys. Rev.*, **93**, 707–16 (*Feb.* 15, 1954).

The fundamental optical absorption and photo-conductivity of single crystals of tellurium has been investigated. Tellurium crystals exhibit dichroism in the infrared, i.e. the absorption constant depends on the polarization of the incident radiation. At 300°K for radiation polarized perpendicular to the *C* axis the absorption edge, located by means of an arbitrary criterion, is at 3·82 microns (0·324 eV), for the case of polarization parallel to the *C* axis the same criterion locates the second edge at 3·29 microns (0·374 eV). The difference between absorption constants survives at wavelengths beyond the edges and is ascribable to the effective masses of the carriers, which depend on their direction of motion relative to the crystal axis. The variation of the energy gaps with temperature has been observed to be -2×10^{-5} eV/°c, i.e. the energy gaps decrease with increasing temperature. Comparison is made with existing theories. The photo-conductivity which is barely detectable at room temperature is considerably enhanced by a reduction of the temperature to 90°K. The spectral response indicates the presence of two peaks corresponding in position to the absorption edges. Measurements of the dependence of photoresponse on voltage, light intensity and shuttering speed indicate that the photoresponse is at least partially in conformity with a monomolecular model. Selenium-tellurium alloys containing 2·7% and 11% selenium by weight and therefore possessing a considerably reduced lattice volume show a shift of photoconductivity and transmission toward shorter wavelengths, i.e. larger energy gaps. A.

535.345.2–15

4390. Study of the OH band of mica in the near infrared. A.-M. Vergnoux, S. Théron and M. Pouzol. *C.R. Acad. Sci.* [*Paris*] **238**, 467–9 (*Jan.* 25, 1954) *In French.*

The infrared spectrum was taken of a slice of muscovite mica, cut parallel to the (001) plane. The light used was polarized along the n_g direction of the monoclinic crystal. Two fine OH bands were observed at 2·74 μ (fundamental) and at 1·42 μ (first harmonic). There was no evidence of any H bridge. The intensity of the bands along the n_g direction was stronger than along n_m. Conclusions could

be drawn about the positions of the OH groups in the crystal. A. J. TAYLOR

535.345.6 : 538.61

Magnetically controlled color filters. *See Abstr.* 4757

535.37

4391. On the law of decay of the luminescence of solid organic substances. V. A. YASTREBOV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 6, 1015–18 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-164.

The phosphorescence decays of a MgOCl-carbazole "cement" phosphor [M. Travnicek, *Ann. Phys. (Leipzig)* **30**, 224 (1937)] and a $Ca(H_2PO_4)$-fluorescein phosphor [H. Chomse, *Z. anorg. allgem. Chem.* **233**, 140 (1937)] were measured. In each case the initial decay has an exponential form, followed by a hyperbolic decay at longer times, suggestive of a recombination process. G. F. J. GARLICK

535.37

4392. The fluorescence of gases [caused] by the deceleration of fast particles. A. E. GRÜN. *Z. Naturforsch.*, **9a**, 55–63 (*Jan.*, 1954) *In German.*

A non-mathematical discussion is given of collision processes in gases, especially the production of secondary electrons and the light excitation due to them. In the experimental work the same spectrum was obtained from any one gas whether excited by 50 kV electrons or by 600 kV protons or H_2^+ ions. The spectra included lines or bands of neutral atoms or molecules, spark lines or bands, and lines of neutral or ionized dissociation products. Pressure variations enabled the effects of primary and secondary excitation to be separated. Energy level diagrams are given for N_2 and CO; other gases used were O_2, H_2, A, A + N_2, Xe + N_2. S. T. HENDERSON

535.371/.372

4393. Spectrum and emission process of crystalline terbium bromate. H. F. GEISLER AND K. H. HELLWEGE. *Z. Phys.*, **136**, *No.* 3, 293–302 (1953) *In German.*

535.371

4394. Investigations on the luminescence of some powder-phosphors. K. GUMIŃSKI AND Z. RUZIEWICZ. *Bull. internat. Acad. Polon. Sci. A, No.* 3–6, 109–21 (*March-June*, 1951).

Samples of KBr–TlCl phosphors are made by grinding the constituents together in an agate mortar. Increase in Tl content increases the u.v. emission but decreases the visible emission. At high Tl content the phosphorescence decay is complex but is exponential for Tl contents less than a few per cent.

G. F. J. GARLICK

535.371

4395. Depolarization of the cathodoluminescence in MgO. B. D. SAKSENA AND L. M. PANT. *Z. Phys.*, **136**, *No.* 4, 463–4 (1953) *In German.*

By using a Nicol prism system it is shown that the luminescence emission of MgO crystals is unpolarized in all the spectral emission bands. G. F. J. GARLICK

535.371

4396. Copper-activated zinc sulfide phosphors with trivalent substituents. H. C. FROELICH. *J. Electrochem. Soc.*, **100**, 496–507 (*Nov.*, 1953).

With increasing concentrations of Cu and H_2S-fired Zn(Al)S : Cu phosphors, the em... spectrum is shifted from green to orange ... 3650 Å excitation. The emission of these ... sulphides consists of three sub-bands of such re... intensities that the presence of a single ban... simulated. The bands have different tempera... decay and excitation characteristics. Among ... substituents, the elements Sc, Ce, Pr and Nd a... interest, as they produce infrared stimulability ... with high activator concentrations. When fir... H_2S with oxide additions, the phosphors wit... emit only green light and become strongly ele... luminescent. The green emission persists a... frequencies from 60 to 15 000 c/s. Phosphors ... pared with 0·1 to 0·4% Cu and with 0·25 to 2·5 m... Al/ mole Cu are nearly equally bright. The ... ratio Cu : Al in the brightest NaCN-washed p... phors is near 1 : 1. The results lend strong sup... to Kroeger's theory of charge compensation. ... complexity of the emission spectra leads to the ... clusion that several species of Cu atoms must ... present in the phosphors. The electrolumines... response is attributed to oxide barriers in, or on, ... phosphors.

535.

4397. Brightness reversal by quenching of exc... phosphors. S. MAGUN AND K. FIEBIGER. *Optik*, ... *No.* 1, 13–17 (1954) *In German.*

A u.v. excited phosphor layer has a photograp... negative image projected on to it by infrared lig... The latter quenches the luminescence in relation to ... negative transparency thus giving a visual posit... image at the phosphor layer. G. F. J. GARLI...

535.3...

4398. Excitation of zinc oxide phosphors by lo... energy electrons. R. E. SHRADER AND S. F. KAIS... *J. Opt. Soc. Amer.*, **44**, 135–9 (*Feb.*, 1954).

The phenomenon of excitation of ZnO phosph... by electrons when the applied voltages are equal ... or less than the equivalent eV of the observed photo... has been investigated. The results suggest that ... ZnO phosphors the energy level distribution is su... that any electron accepted by the crystal lattice regar... less of how small was its velocity in vacuum, has t... ability to produce luminescence.

535.37...

4399. The origin of the fluorescence in self-activate... ZnS, CdS, and ZnO. F. A. KRÖGER AND H. J. VIN... *J. chem. Phys.*, **22**, 250–2 (*Feb.*, 1954).

It is proposed that the luminescent centre in "self... activated" ZnS consists of a cation vacancy whos... nearest surroundings have lost one electron. Suc... a centre is consistent with the fact that at low firin... temperatures, the appearance of the blue fluorescenc... of self-activated ZnS depends upon the presence o... "promoter ions" (monovalent anions or trivale... cations) whereas, if the firing temperature be suff... ciently high, some blue fluorescence is obtaine... without the presence of such promoter ions. Th... luminescence of reduced ZnS, CdS and ZnO is als...

ussed, and is attributed to anion vacancies that e trapped one electron. A.

535.371 : 537.226.2

0. Dielectric constant measurements on doubly vated phosphors. W. Low, A. W. Braun and . Steinberger. Letter in *J. Opt. Soc. Amer.*, **44**, *Jan.*, 1954).

xamination of infrared-sensitive alkaline earth hides and selenides with two rare earth activators ws no dielectric changes to occur on excitation, in trast to the behaviour of ZnS phosphors.

G. F. J. GARLICK

535.371 : 537.312.5

01. Photoluminescence of PbS in the infrared. N. Galkin and N. V. Korolev. *Dokl. Akad. uk SSSR*, **92**, *No.* 3, 529–30 (1953) *In Russian.* glish translation, *U.S. National Sci. Found. SF-tr*-151.

It is shown that layers of photoconducting PbS cited by near infrared radiation emit luminescence the region of 2·8 μ. G. F. J. GARLICK

535.371 : 537.533.8

Effect of organic vapour on the secondary emission phosphors. *See Abstr.* 4606

535.371 : 771.534

Effect of pressure on the fluorescence of the photo- aphic emission. *See Abstr.* 5199

535.371.07 : 621.385.832

402. A luminescent screen for use with very low- locity electrons. S. F. Kaisel and C. B. Clark. *Opt. Soc. Amer.*, **44**, 134–5 (*Feb.*, 1954).

A screen is described which will give visible minescence under excitation by three-volt energy ectrons, at a beam current density of 10 μA/cm². he luminescent screen consists of a layer of ex-ZnO : (Zn) phosphor deposited on conducting lass. Some of the properties of these screens are iscussed. A.

535.372

403. Emission spectra of multiply-activated electro- minescent substances. G. Destriau. *J. Phys. Radium*, **15**, 13–15 (*Jan.*, 1954) *In French.*

The relative intensities of spectral bands characteristic of each activator in phosphors with several ctivators depends on the frequency and magnitude f the exciting electric field. These bands can be lifferent from the normal fluorescence bands and even n the case of phosphors with a single activator the elative intensities at different parts of the single mission band are dependent on field conditions.

G. F. J. GARLICK

535.372

1404. Fluorescence spectrum of triphenylmethyl at 1°K. S. I. Weissman. Letter in *J. chem. Phys.*, **22**, 155 (*Jan.*, 1954).

535.372

4405. Fluorescence spectra of aromatic crystals at low temperature. P. Pesteil and M. Barbaron. *J. Phys. Radium*, **15**, 92–8 (*Feb.*, 1954) *In French.*

At 2 to 20°K the fluorescence spectra of single crystals of aromatic compounds such as tetraphenyl-1.1.4.4 . butadiene-1.3, anthracene, diphenyl and acenaphthene show a fine structure which gives relatively precise information on vibrational states and dipole orientation in the molecular structure.

G. F. J. GARLICK

535.372 : 539.13

4406. Inter- and intramolecular energy transfer processes. III. Phosphorescence bands of some carcinogenic aromatic hydrocarbons. M. M. Moodie and C. Reid. *J. chem. Phys.*, **22**, 252–4 (*Feb.*, 1954).

For Pt II, see Abstr. 347 (1953). The triplet-singlet emission spectra of a number of carcinogenic hydrocarbons are recorded together with the corresponding spectra of their 1,3,5-trinitrobenzene complexes. A new explanation of the complex spectra is given, involving a radiationless transition from an ionic "charge transfer" state to a triplet state complex. A.

535.375.5

4407. Relative intensities of lines corresponding to the longitudinal and transverse optical vibrations in the scattering spectrum of blende. H. Poulet. *C.R. Acad. Sci.* [*Paris*] **238**, 70–2 (*Jan.* 4, 1954) *In French.*

Observations on the relative intensities of these spectral lines of ZnS are interpreted in terms of the linear electro-optical effect of the polarization field.

G. I. W. LLEWELYN

535.375.5 : 539.132

4408. Intensities in Raman spectra. II. Normal co-ordinates for the chloro- and bromo-methanes. D. A. Long and A. G. Thomas. *Proc. Roy. Soc. A*, **223**, 130–7 (*April* 7, 1954).

Application of the intensity theory presented in Pt I [Abstr. 4731)] requires a knowledge of the coefficients $l_{t\xi,p\sigma}$ and $l^{-1}_{p\sigma,t\xi}$ relating the symmetry co-ordinates and the normal co-ordinates. The present paper gives an account of the calculation of these coefficients for the molecules, CCl_4, $CHCl_3$, CH_2Cl_2, CH_3Cl, CBr_4, $CHBr_3$, CH_2Br_2 and CH_3Br. The force field used was that deduced by Decius. An outline of the theory involved in this type of calculation is presented together with some aspects of the numerical manipulation. General expressions for the Wilson $\mathcal{G}$-matrices for these types of compound are quoted and tables of the transformation coefficients for the eight compounds are given. A.

535.375.5 : 539.133

4409. Raman-spectroscopic contribution to the structure of methyl nitrite. J. Wagner. *Acta phys. Austriaca*, **8**, *No.* 2, 175–80 (1953) *In German.*

Raman spectra at +20°C and −80°C show changes in the relative intensities of certain bands. This is explained by supposing a *cis*- form with some hydrogen bonding which decreases at higher temperatures.

G. F. LOTHIAN

535.375.5 : 548.7

4410. Raman effect investigation of the orientation of CN^- ions in the cubic KCN crystals. J.-P. Mathieu. *C.R. Acad. Sci.* [*Paris*] **238**, 74–5 (*Jan.* 4, 1954) *In French.*

It has been found that, at 30°C, there exists an orientation disorder, at least a partial one, of the CN^- ions in the cubic phase of KCN. F. LACHMAN

535.376

4411. Electroluminescent zinc sulfide phosphors. H. H. Homer, R. M. Rulon and K. H. Butler. *J. Electrochem. Soc.*, **100**, 566–71 (*Dec.*, 1953).

The preparation of blue, green and yellow electroluminescent zinc sulphide phosphors is described. The blue and green phosphors contain copper and lead, with the colour being determined by the copper and chloride concentration. The yellow phosphors are triple-activated, containing copper, lead and manganese. A.

535.376

4412. Electroluminescence of insulated particles. L. Burns. *J. Electrochem. Soc.*, **100**, 572–9 (*Dec.*, 1953).

Some mechanisms are considered to explain the luminescence of a region on or near the surface of a semiconducting phosphor particle embedded in a dielectric medium and subjected to an electric field. The localization of the field, the presence of electrons in the conduction band, the colour shift in some phosphors with frequency, the energy levels, and the efficiency of the phosphor are discussed. A.

535.376

4413. On the temperature dependence of electroluminescence of ZnS and ZnO phosphors. H. Gobrecht, D. Hahn and H.-E. Gumlich. *Z. Phys.*, **136**, *No.* 5, 623–30 (1954) *In German.*

Between room temp. and 160°K the phosphors were examined in a liquid silicone dielectric. On cooling the electroluminescence increased gradually, but on reheating large maxima of emission occurred, the main one being near 200°K both for ZnS . Ag and ZnO. Results are shown for different frequencies and voltages. The emission peaks resemble those of thermal glow, but differ in that the electric field must be present. As a working hypothesis it is assumed that the few electrons released thermally from traps are accelerated by the field and then ionize the activator atoms by collision. S. T. HENDERSON

535.376

4414. Brightness waves in electroluminescence and luminous "surface" effects. G. Curie and D. Curie. Letter in *J. Phys. Radium*, **15**, 61–2 (*Jan.*, 1954) *In French.*

By comparing the electroluminescence of SiC with the anodic luminescence of Al for a.c. fields it is seen that the emission from SiC only occurs for one direction of the a.c. field but for both directions in the case of Al. No phase shifts are observed in either case for the emission peaks compared with voltage maxima. It is claimed that the experiment distinguishes the surface effect (SiC) due to a *p–n* junction and the volume effect due to a collision excitation of luminescence centres by accelerated electrons in the internal field of the dielectric. G. F. J. GARLICK

535.376

4415. Radiation from CdS crystals generated by d.c. electric fields. R. W. Smith. Letter in *Phys. Rev.*, **93**, 347 (*Jan.* 15, 1954).

A red emission is obtained from relatively conducting crystals of CdS in d.c. fields of 150 V/cm or less and for operation near to thermal breakdown conditions. For relatively insulating crystals a green emission is observed near the positive electrode fields 10^3 V/cm. Some hole injection is thought occur at this electrode. G. F. J. GAR

535

4416. Electroluminescence in thin films of ZnS : R. E. Halsted and L. R. Koller. Letter in *Rev.*, **93**, 349 (*Jan.* 15, 1954).

Electroluminescence is observed in 10 μ t films of ZnS : Mn (0·5%) phosphor for a.c. fi only, the brightness varying as a high power applied voltage. Dependence of emission on frequency and film temperature is also given. G. F. J. GARL

535.376 : 537.31

4417. The electroluminescence of semiconduc phosphors. A. Fischer. Note in *Z. Naturforsch.*, 756–7 (*Nov.*, 1953) *In German.*

535.39 : 531

4418. On the optical determination of the thickn of "thick" metal films. C. v. Fragstein. *Optik*, *No.* 12, 578–86 (1953) *In German.*

In the determination of film thickness by measurement of the light reflected, and of t transmitted, by the film only approximate formu have been used. These formulae neglected the I of intensity by absorption in the film when calculat the reflection at the second surface. In the case all but weakly absorbing films errors in thickn result which may be as much as 100%. A new a simple formula is proposed which is claimed to g an accuracy of 1% in all cases. H. H. HOPK

535

4419. Two-beam interference: On principles interference and the localization of interfere phenomena. G. Schulz. *Ann. Phys.* [*Leipzig*] *No.* 6–8, 421–8 (1953) *In German.*

Two principles are proposed whose applicatio permit the recognition of the spatial distribution interference phenomena. A principle of "agreei orders" is formulated and through its means t localization of interference is determined for a simp wedge, the case being that in which there is sm extension of the light source. The second princip is called the principle of the "beams with the sam direction". Both the two- and the three-dimension cases are evaluated. S. TOLANSK

535.4

4420. On the intensity distribution of spectral lin in the Fabry–Perot interferometer. K. Krebs an A. Sauer. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 359–6 (1953) *In German.*

The intensity distribution is calculated as a functio of plate reflectivity ρ and of the half-value width o the Doppler broadening μ. The resulting series computed and shown in tables and curves for value of ρ between 94 and 61% and of μ (expressed as fraction of the order separation) between 0·02 an 0·40. G. F. LOTHIA

535.41

4421. A shearing interferometer with fixed shea and its application to some problems in the testing o astro-optics. D. Brown. *Proc. Phys. Soc.* [*London*] *B* **67**, 232–7 (*March*, 1954).

A wavefront shearing interferometer is describe

sisting of a cemented unit which introduces a d shear and tilt between the identical interfering vefronts. This construction results in an instru- nt which maintains correct compensation and y be very easily and quickly set up and inter- nged with other test equipment. The use of such nented units to measure on- and off-axis aberrations der workshop conditions is also described. A.

535.417 : 523.77

Interferometric measurements of wave-lengths. *See str.* 4123

535.417 : 531.711

22. On the possibility of using radiations of stable lmium isotopes of even mass number for the repro- ction of the unit of length. N. R. BATARCHUKOVA, I. KARTASHEV AND M. F. ROMANOVA. *Dokl. ad. Nauk SSSR*, **90**, *No.* 2, 153–6 (1953) *In ussian.* English translation, *U.S. National Sci. und. NSF-tr-107.*

Electrodeless tubes containing the separate isotopes re used to examine the red line with a Fabry–Perot lon with various separations up to 100 mm. None the three lines show any hyperfine structure and y is regarded as suitable for a standard. The avelengths measured with a r.m.s. error of about 0·0001 Å are (taking natural cadmium as 38·4696 Å): Cd^{112}, 6438·4690 Å; Cd^{114}, 6438·4677 Å; Cd^{116}, 6438·4664 Å. G. F. LOTHIAN

535.417 : 531.719.1

423. The interferometric evaluation of the radius r curvature for spherical and parabolic surfaces rough use of a spherical standard of known approxi- ately equivalent radius of curvature. J. PICHT. *ptik*, **10**, *No.* 12, 587–602 (1953) *In German.*

A detailed geometric analysis of the interference etween two curved surfaces. All the necessary rmulae are derived. The theory is applied to fringe atterns formed between two spherical surfaces and etween spherical and paraboloid surfaces.

S. TOLANSKY

535.417 : 531.74

424. An interferometric device for measuring tilts. t.. BREIN. *Optik*, **10**, *No.* 10, 492–7 (1953) *In German.*

For testing, precision levels are placed on a rocking able 1 m long, which rests at the middle on a knife dge, one end of the table being raised or lowered by eans of a micrometer screw. A movement of 1 μ f the latter produces a tilt of 0·4″, and this accuracy insufficient for the testing of levels reading to 1″. o improve this accuracy a simple Fizeau interfero- eter is arranged at each end of the table. In this ay an angular displacement of 0·01″ is easily easured. The apparatus has been used to study a) errors in the knife edge, (*b*) errors due to sticking f the bubble and (*c*) errors associated with non- niform curvature and the state of polish of the nterior surface of the bubble glass. H. H. HOPKINS

535.42 : 538.566

425. Diffraction theory. C. J. BOUWKAMP. *Rep. Progr. Phys.*, **17**, 35–100 (1954).

A critical review is presented of recent progress in lassical diffraction theory. Both scalar and electro- nagnetic problems are discussed. The report may erve as an introduction to general diffraction theory although the main emphasis is on diffraction by plane obstacles. Various modifications of the Kirchhoff and Kottler theories are presented. Diffraction by obstacles small compared with the wavelength is discussed in some detail. Other topics included are: variational formulation of diffraction problems, the Wiener–Hopf technique of solving integral equations of diffraction theory, the rigorous formulation of Babinet's principle, the nature of field singularities at sharp edges, the application of Mathieu functions and spheroidal wavefunctions to diffraction theory. Reference is made to more than 500 papers published since 1940. A.

535.421

4426. Dispersion and resolution of a plane grating under high angles of incidence and diffraction. R. VOLLMER. *Optik*, **10**, *No.* 10, 497–500 (1953) *In German.*

It is shown that an observed improvement in relative dispersion at high angles of incidence and diffraction is associated with the smaller line-broadening produced by the finite width of the slit in these circumstances. H. H. HOPKINS

535.421 : 535.33.07

4427. Multiple diffraction in grating spectroscopy. W. G. FASTIE AND W. M. SINTON. *J. Opt. Soc. Amer.*, **44**, 103–8 (*Feb.*, 1954).

Double mirrors are used in the focused spectrum of diffraction gratings to invert the spectrum and return the radiation to the grating a number of times. After three or four diffractions from low orders, resolution is observed which is equivalent to that available in the highest orders. An additional double-mirror system is described which separates the spectra, obtained after several diffractions, from other spectra. The problem of multiple diffraction with long-curved slits is discussed, and a modification of the Ebert monochromator is suggested for high-resolution multiple-diffraction spectrometry. A.

535.43

4428. Numerical evaluation of the Mie scattering functions; table of the angular functions π_n and τ_n of orders 1 to 32, at 2·5° intervals. F. T. GUCKER, JR AND S. H. COHN. *J. Colloid Sci.*, **8**, 555–74 (*Dec.*, 1954).

In connection with a programme of calculating the light-scattering properties of isotropic spherical particles over a wide range of the parameter α and refractive index m, the angular functions π_n and τ_n have been tabulated for values of the angle 0° (2·5°) 180°, and orders 1 to 32. The following suggestions are made toward standardizing and simplifying the form of the Mie scattering coefficients: (1) Use of van de Hulst's scattering coefficients a_n and b_n. (2) Use of the scattering angle θ measured from the forward direction of the propagation of the incident light, as suggested by Stratton and van de Hulst. (3) Incorporation of the factor $F(n) = (2n + 1)/n(n + 1)$ into the augmented angular functions, $\Pi_n(x) = F(n)\pi_n(x)$ and $T_n(x) = F(n)\,\tau_n(x)$, which are independent of particle size and refractive index, instead of the coefficients A_n and P_n, which are functions of these variables. (4) Use of a suitable transformation to express the scattering functions for real arguments in terms of real-valued functions only, eliminating all

derivatives and separating the terms which are functions of β alone from those which are functions of β, m. The functions of β, m, may be calculated by means of a simple recurrence formula which is particularly useful when the refractive index is complex. Equations are given for calculating the Stokes parameters, which completely characterize the scattered light, when a spherical particle is illuminated with light plane-polarized in an arbitrary direction. A.

535.43

4429. Experimental study of the Rayleigh scattering of quartz in polarized light. L. TAUREL AND J. CHAPELLE. *C.R. Acad. Sci.* [*Paris*] **237**, 1510–11 (*Dec.* 9, 1953) *In French.*

Experimental details are given and the intensities of components of the scattered light are tabulated. The results are compared with theory using existing data for the optical constants. The agreement is good except in one case which is attributed to the possible inaccuracy of the optical constants. H. G. JERRARD

535.43

4430. The wavelength of scattered radiation. A. BRAMLEY. Letter in *Phys. Rev.*, **93**, 246 (*Jan.* 1, 1954).

Reviews observations of the small red shift in the Rayleigh line. G. F. LOTHIAN

535.43

4431. Measurement of the absolute intensity of molecular scattering of light by a quartz crystal. L. TAUREL AND J. CHAPELLE. *C.R. Acad. Sci.* [*Paris*] **238**, 73–4 (*Jan.* 4, 1954) *In French.*

The results of measurements on quartz are compared with those on benzene. H. G. JERRARD

535.434 : 539.133

4432. Light scattering by very large molecules: application of transmission method to actomyosin. M. L. R. HARKNESS AND A. WASSERMANN. Letter in *Nature* [*London*], **173**, 167–8 (*Jan.* 23, 1954).

Measurements in dilute solution indicate that the actomyosin molecule is a polydisperse coil of weight 2×10^8. G. F. LOTHIAN

535.434.07 : 621.383 : 621.317.79

4433. A submersible photoelectric absorptiometer. L. J. SCRAGG, R. BRIGGS AND G. KNOWLES. *J. sci. Instrum.*, **31**, 75–7 (*March*, 1954).

An instrument developed to measure turbidity in rivers comprises a lamp and 20-element barrier-layer photocell which are lowered in cylinders fitted with windows; a second photocell accompanies the lamp to compensate automatically for variations in its brightness. Cables run to a simple vacuum-tube voltmeter at the surface. The range is 0·01 to 100% transmission, and readings can be made to a depth of 100 ft. Power is from accumulator and dry battery. The description includes simple methods of making cable-entries and windows water-tight although demountable. A.

535.435

4434. Light scattering determination of the absolute turbidity of water. D. A. I. GORING AND P. G. NAPIER. Letter in *J. chem. Phys.*, **22**, 147 (*Jan.*, 1954).

Integration of measured values of scattered intensity permit calculation of the turbidity. Experimental results are given. G. F. LOTHIAN

535

4435. The molecular scattering of light by bi… mixtures: experimental verification of the Ein… formula on the mixture carbon disulphide, ace… M. DESTRIAU, R. LOCHET AND A. ROUSSET. … *Acad. Sci.* [*Paris*] **238**, 61–3 (*Jan.* 4); Erratum, … (*Jan.* 25, 1954) *In French.*

These liquids were chosen to show a large varia… of scattered intensity (I) with relative concentra… (c). The I, c curve measured for green light agrees … with the Einstein equation. G. F. LOTH…

535

4436. The degree of polarization of the com… polarizers. J. BRANDMÜLLER AND E. HOFMEIS… *Optik*, **11**, 1–12, *No.* 1 (1954) *In German.*

If the intensities of the light emerging fro… polarizer in planes parallel and perpendicular to … vibration direction are J_1 and J_2 respectively, then … degree of polarization P is defined as the ratio … $J_1 - J_2$ to $J_1 + J_2$. Details of measurement of P … briefly described. Values of P for Nicol and Gl… Thompson polarizing prisms, interference polariz… and dichroic polarizers due to Bernauer [*Fortschr… der Mineralogie, Kristallographie und Petrographie*, … 22 (1935)], Land (polaroid) [Abstr. 1688 (1952)] a… Käsemann [Abstr. 3882 (1949)] are given. The val… depend on the parallelism of the incident light wh… is fully discussed for polarization prisms. T… polarization fields of the latter are treated in detail: … Glan–Thompson field approaches the ideal. … nearly parallel light all the polarizers give values o… approaching 100%. Transmission values are high … polarizing prisms and interference polarizers but mu… less for dichroic polarizers. H. G. JERRA…

535

4437. Some observations on the time edge effect … Catalin 800. A. R. MORRIS. *Brit. J. appl. Phys.*, … 104–6 (*March*, 1954)

The investigation shows that the "time edge" eff… in the phenol-formaldehyde type of resin is accelerat… by exposure to oxygen and moisture and retarded … storage at low temperatures. It is also noted that t… time edge effect apparently proceeds in two stages.

535.55 : 537.228

4438. Piezo-optic and electro-optic properties … zinc blende [ZnS]. R. KARA, J.-P. MATHIEU AN… H. POULET. Letter in *J. Phys. Radium*, **15**, 60… (*Jan.*, 1954) *In French.*

The birefringence developed in ZnS under t… action of uniform pressure or of an electric field w… measured for green Hg radiation using a Babin… compensator. The measurements are simplified f… ZnS because it has no rotatory power. The piez… optic constant (p_{44} of Cady, a_{44} of Pockels) was foun… to be $p_{44} = -0{\cdot}0044 \pm 0{\cdot}0006$. The electro-opt… constant (r_{41} of Cady, e_{41} of Pockels) was found to b… $r_{41}\eta' = 6{\cdot}4\times10^{-8} \pm 0{\cdot}3\times10^{-8}$ c.g.s. (η' = electr… susceptibility at constant stress, χ of Pockels). If th… birefringence measured in the electric field was du… solely to the deformation produced by the convers… piezoelectric effect, $r_{41}\eta'$ should equal $p_{44}d_{14}$. Cad… gives $d_{14} = -9{\cdot}7\times10^{-8}$ whence $p_{44}d_{44} = 0{\cdot}042\times$… 10^{-8}. This value is much lower than the observe… value of $r_{41}\eta'$ which shows that the electric field has … direct effect on the birefringence. H. J. H. STARK…

535.55 : 541.64

4439. Mechanical birefringence of high thermoplastic polymers. A. WINAVER. *C.R. Acad. Sci. [Paris]* **238,** 463–5 (*Jan.* 25, 1954) *In French.*

Results of photoelastic measurements on methyl polymethacrylate and polystyrene are presented. Graphs show the variation of the photoelastic constant with temperature and the birefringence with time. The birefringence is measured by Chaumont's method. An explanation of the results is given.

H. G. JERRARD

535.65

4440. Multichromatic colorimeters. J. COHEN. *Illum. Engng*, **49,** 50–8 (*Jan.*, 1954).

Describes a dispersion and template form of colorimeter in which the dispersion is produced by a diffraction grating and various different forms of template can be used, so that either half of the bipartite field can be illuminated with light of any desired spectral distribution. Details of calibration are given.

J. W. T. WALSH

535.65

4441. Transformation of chromaticity diagrams. F. J. BINGLEY. *J. Opt. Soc. Amer.*, **44,** 109–12 (*Feb.*, 1954).

Shows how, by geometric construction, it is possible to construct corresponding points on a pair of chromaticity diagrams. To do this requires only that four pairs of corresponding points be known; all other pairs of corresponding points are then uniquely determined. The method finds specific application where one of the chromaticity diagrams is arbitrary (such as one drawn in terms of the primaries of a colorimeter), and the other is the CIE diagram. It is then possible to transform the colorimeter readings directly to the CIE diagram, provided four calibrating points are known. It is shown that four corresponding lines in the two diagrams will enable complete mapping of corresponding points. The appendix gives a formal proof of the projective properties of chromaticity diagrams and serves as a rigorous basis for the methods developed in the body of the paper. A.

535.65 : 535.89

4442. Spectral energy distribution of the International Commission on Illumination light sources A, B, and C. R. DAVIS, K. S. GIBSON AND G. W. HAUPT. *J. Res. Nat. Bur. Stand.*, **50,** 31–7 (*Jan.*, 1953). For abstract see Abstr. 3197 (1953).

535.7 : 612.84

Physiological optics. *See Abstr.* 5194–5

535.8

4443. Centricity control of optical systems. R. BUBÁKOVÁ-KUČEROVÁ. *Czech. J. Phys.*, **1,** *No.* 3–4, 201–4 (1952).

The existing method of controlling the centricity of optical systems in reflected light can be simplified by placing an auxiliary optical system having a short focal distance in front of the objective being tested. Reflections from all surfaces of the system under test can then be seen simultaneously in the field of the microscope and it can be recognized at first glance whether it is centric or not. A.

535.8

4444. On the preparation of patent specifications for inventions relating to optical systems. E. NÄHRING. *Optik*, **10,** *No.* 10, 485–92 (1953) *In German.*

Describes the general principles upon which patent protection is based, and explains the consequencies of a decision of the German patent office in 1944 affecting patent specifications relating to lens systems.

H. H. HOPKINS

535.81

4445. Cementing optical glasses to obtain strong joints free from striae. E. DJURLE, E. INGELSTAM AND L. JOHANSSON. *J. sci. Instrum.*, **31,** 86–90 (*March*, 1954).

Some techniques are described for cementing optical elements, especially at large glass surfaces, together with plastics. Successful joints, vein-free and strong, have been made with certain types of plastics. A rapid semi-quantitative method of examining glass for internal striae is also described. A.

535.822.17 : 535.822.8

4446. A phase-contrast searcher for the Burch reflecting microscope. R. J. KING. Letter in *Nature [London]* **173,** 220–1 (*Jan.* 30, 1954).

An attachment for u.v. microscopy allows searching and focusing in visible light, with unstained specimens. An optical system containing a phase plate fits into the eyepiece tube of the microscope and an auxiliary lens swings into the light beam to form an image of the objective mirror upon the phase plate. R. W. FISH

HEAT 536

536.2 : 536.3

4447. Temperature distribution along a wire electrically heated *in vacuo*. K. S. KRISHNAN AND S. C. JAIN. Letter in *Nature [London]* **173,** 166–7 (*Jan.* 23, 1954).

It is stated that the integral equation for the distribution in terms of three parameters may be expanded into power series integrable term by term to yield rapidly convergent series. A review of some of the results is given and it is said that experimental results verify in detail the theoretical deductions.

F. E. HOARE

536.2 : 551.46

The flow of heat through the Atlantic Ocean. *See Abstr.* 5176

536.212.2

4448. The thermal conductivity of monovalent metals. P. G. KLEMENS. Letter in *Proc. Phys. Soc. [London] A*, **67,** 194–6 (*Feb.*, 1954).

Theoretical. Numerical solution of Bloch's integral equation at low temperatures is stated to give a result which exceeds by 11% the value obtained in the third approximation of Sondheimer's method [Abstr. 8687 (1950)]. It is suggested that the discrepancies between theory and experimental results on Na, Cu, Ag, Au may be largely removed by assuming that conduction electrons interact with transverse as

well as longitudinal lattice waves, and that in the case of the noble metals the Fermi surface touches the zone boundary. E. H. SONDHEIMER

536.212.3

4449. A transient-flow method for determination of thermal constants of insulating materials in bulk. I. Theory. J. H. BLACKWELL. *J. appl. Phys.*, **25**, 137–44 (*Feb.*, 1954).

The work was first suggested by the geophysical problem of determining the thermal constants of natural rock *in situ*. A cylindrical "thermal probe", containing heat-source and thermometer, is inserted in the medium and constants deduced from a record of probe temperature *v.* elapsed time; an attempt was made to eliminate or evaluate the effect of, physical idealizations inherent in previous applications. A new approximate mathematical treatment was developed, using methods of the operational calculus first suggested by S. Goldstein, in 1932. A.

536.23

4450. Thermal conduction in rarefied gases. The accommodation coefficient. F. M. DEVIENNE. *Mem. Sci. phys., No.* 56, 74 *pp.* (1953) *In French.*

Review article. Main topics: expressions for heat transfer in terms of the accommodation coefficient (*a*) and the temperature jump (*g*); the relation between *a* and *g*; methods used to measure *a* and *g* and their results; the main theories—particularly that of Devonshire which is the most successful; application to Pirani gauge, Knudsen absolute manometer, detection of absorbed films and measurement of C_v. The outstanding experimental difficulty is that of getting reproducible surfaces which can be used to find the dependence of *a* on *p* and *T* and the effect of surface films. 140 references. R. O. DAVIES

536.23 : 533.16

4451. The thermal conductivity of organic vapours. The relationship between thermal conductivity and viscosity, and the significance of the Eucken factor. R. G. VINES AND L. A. BENNETT. *J. chem. Phys.*, **22**, 360–6 (*March*, 1954).

The thermal conductivities of 31 polar and non-polar organic vapours have been determined at pressures up to one atmosphere, over a temperature range from 40 to 160°C. The relation between thermal conductivity and viscosity is discussed in terms of the expression:

$$K^{\circ}M/\eta C_{v0} = f = (f_{\text{trans}}C_{v\text{trans}} + f_{\text{int}}C_{v\text{int}})/C_{v0}$$

where, following a suggestion by Eucken, the ratio f is divided into separate components f_{trans} and f_{int}, corresponding to the different rates of transfer of translational and "internal" (vibrational and rotational) energies. Experimental values of f are not in accord with Eucken's original assumption that $f_{\text{int}} = 1$. For non-polar vapours f_{int} increases towards a high-temperature limit which is close to the theoretical value of 1·3. For polar vapours f_{trans} appears to be less than the theoretical value of 2·5, the decrease depending on the polar character of the molecule. These results are discussed with reference to energy exchanges occurring during collisions between complex molecules. A.

536.23 : 533

A comparative study of accommodation coefficie by the temperature jump and low-pressure methods thermal conductivities of He, Ne and CO_2. *Abstr.* 4269

536.24 : 537

4452. The effect of electric fields on the heat trans of gases. H. SENFTLEBEN AND E. BÜLTMANN. *Phys.*, **136**, *No.* 4, 389–401 (1953) *In German.*

See Abstr. 208 (1949), 921 (1950). The interpre tion of the enhancement of the thermal convecti by electrostriction can be incorporated into t general treatment of heat transfer by introduci appropriate dimensionless numbers. The form of t equations, which represent the measurements sat factorily, becomes quite simple in spite of their wi field of application. H. LONDO

536.2

4453. Heat exchangers in an isothermal envelop M. VÉRON AND F. TRÈVES. *C.R. Acad. Sci.* [*Par* **238**, 329–31 (*Jan.* 18, 1954) *In French.*

The laws of temperature evolution in heat exchang in isothermal enclosures, as used by certain industrie are discussed. F. E. HOAR

536.2

4454. Heat transfer measurements at sodium stainless steel interface. J. W. MOYER AND W. A RIEMEN. *J. appl. Phys.*, **25**, 400–1 (*March*, 1954).

Experiments to measure the heat-transfer coefficien at a sodium/type-347 stainless steel interface ar described. The temperature range is 100–500°C It is concluded that wetting does not play a significan role in the heat transfer. A

536.2

4455. Heat transfer by free convection in an open thermosyphon tube. B. W. MARTIN AND H. COHEN. *Brit. J. appl. Phys.*, **5**, 91–5 (*March*, 1954).

An experimental investigation of the heat transfer by free convection in a heated vertical tube closed at its lower end. To cover a wide range of physical properties of the convective fluid, glycerine, water and air were used. The trends are shown to be in generally close agreement with theoretical prediction. A.

536.25 : 532.51

4456. The solution of the differential equation occurring in the problem of heat convection in laminar flow through a [circular] tube. M. ABRAMOWITZ. *J. Math. Phys.*, **32**, 184–7 (*July–Oct.*, 1953).

The discussion of forced heat convection in laminar flow through a circular tube, on the assumption that the velocity distribution of the fluid corresponds to the Poiseuille flow, requires solution of the differential equation $d^2y/dr^2 + (1/r)dy/dr + \beta^2(1 - r^2)y = 0$, subject to boundary conditions that (1) the temperature at the mouth of the tube is constant, and (2) no heat transfer occurs at the surface of the tube. In order to satisfy the second of these conditions, the parameter β must have an infinite number of discrete values, β_s. Difficulties associated with a procedure for determining proper values of β_s are briefly referred to; considerable arithmetical calculation is necessary. A solution of the equation in terms of Bessel functions, more convenient for determining the

alues of β_s, is derived, in the form $y(r, \beta) = \sum_{n=0}^{n=\infty} A_n(\beta)\Omega_n(\beta r)$, where $\Omega_n(\beta r) = (\beta r)^n J_n(\beta r)$. The alues of β_s are deduced by determining the zeros f the function $y(r, \beta) = \sum_{n=0}^{n=\infty} A_n(\beta)(\beta r)^n J_n(\beta r)$. The rst five values of β_s are calculated and tabulated, nd agree closely with values calculated by Lauwerier y means of his asymptotic expansion [*Appl. Sci. Res.*, **A2**, 184 (1951)]. J. S. G. THOMAS

536.411 : 536.71

4457. Equation of state of gases. Methods of measurement of variations in volume of fluids up to 10^4 kg/cm² pressure and 200°[C], and method of measurement for temperatures up to 1200°[C]. I. Description of apparatus. JAS. AND JAC. BASSET. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 47 A–56 A (*Jan.*, 1954) *In French.*

Two arrangements, one suitable for the lower temperature and the other for the higher, are described in detail. In the first a known volume of the gas is trapped, under pressure, in a Pyrex bulb consisting of three compartments separated by capillaries and containing W contacts, and the variations of this volume as a function of pressure are measured. The bulb is suspended over a Hg bath isolated from the walls of the external chamber which can be heated to 200°. The variations in volume are determined electrically and electrical mechanisms permit the raising and lowering of the bulb into the bath and other adjustments without dismounting the apparatus. In the second arrangement the thermal expansion of the gas contained in a container of known volume, which is heated gradually to the maximum temperature, is measured. The variation in weight of an Al block immersed in the hot gas under pressure is determined in one form of the apparatus and in another the dilatation of the gas in a Pt bottle with capillary stem closed by Hg is determined directly. The ranges and accuracies of the methods are discussed. S. WEINTROUB

536.413 : 536.48

4458. Thermal expansion of simple solids at low temperatures and Grüneisen's law. D. BIJL AND H. PULLAN. *Phil. Mag.*, **45**, 290–4 (*March*, 1954).

Experimental results on the thermal expansion of copper, aluminium, and iron are discussed in relation to Grüneisen's law. This law is shown to break down at temperatures below about $0{\cdot}3\theta$, the thermal expansion becoming bigger than the values predicted by Grüneisen's law. A possible explanation is given. A.

536.421.1 : 536.71 : 539.11

4459. The Simon melting equation. L. SALTER. *Phil. Mag.*, **45**, 369–84 (*April*, 1954).

The Simon melting equation $p_m/a = (T_m/T_0)^c - 1$ is derived assuming the validity of the Grüneisen equation of state and the Lindemann melting formula along the melting line. A relation between c and Grüneisen's γ is derived and discussed in view of available experimental data. Poor agreement is found in the case of the alkali metals, the agreement for argon being satisfactory. A consequence of possible geophysical interest arising from the theory is discussed. The detailed data available for solid helium are used to study the assumptions underlying the theory. A.

536.423

4460. The liquid-vapour equilibrium of the binary system argon/oxygen. A. M. CLARK, F. DIN AND J. ROBB. *Proc. Roy. Soc. A*, **221**, 517–34 (*Feb.* 9, 1954).

The vapour pressures of condensed liquid mixtures of argon and oxygen of known composition were measured by means of a differential mercury manometer with reference to the vapour pressure of pure argon. From these results it is possible to determine the bubble-point curves of the system over a series of fixed temperatures. In the second part of the experimental work the composition differences between liquid and vapour phases in equilibrium were determined at three constant temperatures by a static method. The results have been extensively checked and smoothed by graphical and analytical methods. A test for thermodynamic consistency has been applied, and it is believed that the results are consistent within the accuracy of the assessment. The final data are presented in tabular form for rounded-off values of composition and temperature. Constants and formulae have been worked out which enable values to be calculated for any pressure, temperature or composition. A.

536.423 : 536.44

4461. A rectilinear diameter law of mole fractions for binary liquid-vapor coexistence regions near the critical locus. S. W. BENSON, P. E. M. ALLEN AND C. S. COPELAND. *J. chem. Phys.*, **22**, 247–9 (*Feb.*, 1954).

It has been found that in the neighbourhood of the critical locus of many nonazeotropic binary, liquid-vapour systems at equilibrium, the sum of the mole fractions in the two phases of each of the two components (C,C') may with reasonable precision be represented by the relationship $X_v + X_l \equiv 2 - (X_v + X_l') = a \log P/P_0'$; in which X_v and X_l are the mole fractions of the more volatile component (C) in vapour and liquid, respectively, which are in equilibrium at total pressure P at constant temperature, P_0' is the vapour pressure of the less volatile component C', and a is a constant for each isotherm. Between the critical temperatures of the two components a shows greater temperature dependence as the lower critical temperature is approached. A.

536.423 : 536.75

4462. Isotherms and thermodynamical functions of ethane at temperatures between 0°C and 150°C and pressures up to 200 atm. A. MICHELS, W. VAN STRAATEN AND J. DAWSON. *Physica*, **20**, 17–23 (*Jan.*, 1954).

Compressibility isotherms and thermodynamical functions of ethane are given for the temperature range 0°–150°C and for densities up to 180 Amagat. A.

536.423.1

4463. On the dynamics of evaporation of polycomponent solutions in a non-volatile solvent. L. I. RUBINSHTEIN. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 767–9 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-132.

See Abstr. 3371 (1954). The process is studied

under assumptions (*a*) and (*b*). The concentrations are supposed to be functions of one spatial variable only, and the time, so that the relevant equation is that of heat-conduction along one dimension. The approximation is made of dealing only with the initial evaporation surface, instead of with a time-varying boundary. This will be the more accurate, the thinner the evaporating layer. The functional equations for the gradients of the concentration at the origin can now be solved exactly by means of the Laplace transformation. A. J. TAYLOR

536.423.15 : 533.75

4464. An exact vapour pressure equation. A. J. GOTTSCHAL AND A. E. KORVEZEE. *Recueil Trav. chim. Pays-Bas*, **72**, 465–72 (*June*, 1953).

A general vapour pressure equation is derived from the thermodynamic equilibrium condition. For pressures under or slightly over one atmosphere, where the equation of state $pv = RT + Bp$ is valid for the vapour, three correction terms must be added to $\log p$ to obtain $(\log p)_{corr} = -A/T + D$. The three correction terms can be calculated from precise specific heat and density data for either phase. The variation of the heat of vaporization with temperature is shown to depend on the same data. A.

536.423.15 : 536.555

4465. Vapour pressures and heats of vaporization of benzene. A. J. GOTTSCHAL AND A. E. KORVEZEE. *Recueil Trav. chim. Pays-Bas*, **72**, 473–82 (*June*, 1953).

Starting from two chosen experimental vapour pressure values of benzene, the vapour pressure curve up to the boiling point and the heats of vaporization along this curve have been calculated. The necessary additional information concerns specific heats and specific volumes. The formulae have been taken from the preceding paper. The resulting vapour pressures are compared with the more recent Antoine equations. The heats of vaporization found along the same line prove to be in agreement with the calorimetric observations. Moreover, the calculations reveal with an appreciable precision the true form of the $\Delta H(T)$ relationship for benzene. A.

536.423.4

4466. The use of a diffusion cloud chamber to characterize condensation nuclei. D. SCHIFF, H. I. SCHIFF AND P. R. GENDRON. *Canad. J. Chem.*, **31**, 1108–17 (*Dec.*, 1953).

The original Langsdorf diffusion cloud chamber has been modified so that the temperature gradient obtained can be controlled. The supersaturations thus produced can be calculated from a diffusion equation. The effectiveness of various inorganic nuclei in causing condensation in this supersaturated vapour has been studied. A.

536.44 : 541.123.2

4467. Critical phenomena in the cyclohexane–aniline system. D. ATACK AND O. K. RICE. *J. chem. Phys.*, **22**, 382–5 (*March*, 1954).

Measurements have been made on the transition temperatures between one-phase and two-phase conditions in the cyclohexane–aniline system and on the densities of the coexisting phases, using an improved temperature control. The region of extreme cloudiness or wet fog, where the meniscus, if present, can be seen, and where density measurements are difficult because the density float cannot be seen, was investigated by means of a technique suggested by Zimm. In this procedure the temperature was raised, without stirring, to clear the wet fog without removing any density gradients which might have formed. The previous results of Rowden and Rice and Atack and Rice have been substantiated, and it is concluded with stronger evidence that there is an appreciable range of critical concentrations over which the transition temperature is constant.

536.

4468. Theory of linear flame propagation. I. Existence, uniqueness, and stability of the steady state. D. LAYZER. *J. chem. Phys.*, **22**, 222–9 (*Feb.*, 1954).

It is shown that the equations governing the steady adiabatic, one-dimensional propagation of single reaction flames admit an infinity of solutions, only one of which, however, can be realized physically. The steady state is shown to be stable against small perturbations, and the possibility of reconciling this result with apparently contradictory experimental data is discussed.

536.462 : 536.52

4469. Use of the sun in flame temperature problems. R. H. WILSON, JR. Note in *Publ. Astron. Soc. Pacific*, **65**, 295–6 (*Dec.*, 1953).

The temperature of the $(CN)_2$–O_2 flame, for stoichiometric mixture at atmospheric pressure, which is estimated theoretically at $\sim 4800°K$, was measured [for method see Abstr. 8835 (1952)] as $4640° \pm 150°K$, using the sun as a background radiator with an immediately measurable effective temperature. Reversal of the red line of Li in the flame projected on the continuous solar background indicated the equality of the two temperatures. F. LACHMAN

536.48 : 536.63

4470. A λ-anomaly in the specific heat of solid hydrogen. R. W. HILL AND B. W. A. RICKETSON. *Phil. Mag.*, **45**, 277–82 (*March*, 1954).

The specific heat of solid hydrogen was measured as a function of the ortho/para concentration in the temperature range from $1{\cdot}15°K$ to the triple point. It is shown that the specific heat contribution of the ortho molecules is anomalous throughout this region, and that the anomaly assumes a co-operative character at the lowest temperatures for specimens rich in orthohydrogen. The temperature of the maximum of the co-operative anomaly is at $1{\cdot}6°K$ in normal hydrogen, but shifts rather rapidly to lower temperatures with falling orthohydrogen concentration. Considerations of the entropy show that the entire anomalous behaviour can be associated with the ordering of the rotations of the ortho molecules. A.

536.48

4471. The thickness of the helium film. L. MEYER. *Phys. Rev.*, **93**, 655–6 (*Feb.* 15, 1954).

It is suggested that the change in thickness of the helium film at the λ-point is not caused by any essential change in the thermodynamic relation between film thickness, pressure and temperature. It can be a result of the onset of superfluidity below the λ-point

hich causes a great change in the rate of approach to uilibrium and consequently of the average of the m thickness during the experimental fluctuations of essure and temperature. A.

536.483 : 531.788 : 533.5

Measurement of high vacuums at low temperatures. *ee Abstr.* 4253

536.483 : 531.732

Liquid level indicator for condensed gases at low mperatures. *See Abstr.* 4215

536.5 : 533.6.011.5

472. Design and calibration of stagnation temperare probes for use at high supersonic speeds and elevated temperatures. E. M. WINKLER. *J. appl. Phys.*, 5, 231–2 (*Feb.*, 1954).

A probe with a single platinum-coated silica shield as built. For large Reynolds numbers the temperare recovery factor of the probe reaches 0·998. It ecreases with decreasing Reynolds number and inreasing temperature. At temperatures up to 700°K he major thermometric losses of the probe are conuction losses. One single calibration curve is btained for any one probe by relating the calibration ata to the flow conditions inside the probe. A.

536.5.081 : 536.48

473. The measurement and the calculation of the quid helium vapor pressure-temperature scale from ° to 4·2°K. R. A. ERICKSON AND L. D. ROBERTS. *Phys. Rev.*, **93**, 957–62 (*March* 1, 1954).

Measurements between 1·2 and 4·2°K on a paramagnetic salt using a mutual inductance bridge pparatus indicate errors in the presently accepted quid helium temperature scale amounting to 2 millidegrees at the λ-point. These data, together vith those of Kistemaker, are found to be in good greement with a temperature scale calculated from he other thermodynamic properties of helium. The alculated scale is further confirmed by a comparison etween the calculated and observed latent heat of aporization. Accepting as correct the boiling point letermination of Keesom and Clusius, the estimated ccuracy of the proposed temperature scale is 1·5 nillidegrees below the λ-point and 3 millidegrees above he λ-point. A.

536.532

474. A wide-range thermistor radiometer for the neasurement of skin temperature and environmental adiant temperature. A. M. STOLL. *Rev. sci. nstrum.*, **25**, 1847 (*Feb.*, 1954).

The thermistor radiometer consists of a Wheatstone ridge formed of four thermistors, two of which are xposed to incident radiation and two of which are idden from it and act as thermal compensators. The utput from the bridge is suitably amplified and fed nto a microammeter on which deflections are read in microamperes and related to radiant temperatures by neans of calibration charts. Calibrations are made against standard blackbody radiators and at present ave been carried out for use of the instrument in mbient temperatures between −50°C and +30°C for neasuring radiant temperatures between −185°C and +60°C. The instrument has been used successfully in (1) the measurement of skin temperatures indoors at normal room temperature and outdoors in ambient temperatures as low as −45°C; and (2) the measurement of the radiant temperature of the sky and ground in temperate and in arctic climates. A.

536.532

4475. Modified 1913 reference tables for iron–constantan thermocouples. R. J. CORRUCCINI AND H. SHENKER. *J. Res. Nat. Bur. Stand.*, **50**, 229–48 (*May*, 1953).

An investigation was made of the characteristics of iron–constantan thermocouples typical of those being supplied to reproduce the standard temperature-electromotive force relationship that was established commercially in 1913. Using the calibration of the thermocouple that most nearly matched the 1913 reference table over the range to which iron–constantan thermocouples usually are limited (32° to 1400°F), a slightly different temperature-electromotive force relationship was derived which is more nearly realizable by commercially available materials. The new relationship is presented in four mutually consistent tables covering the range, −320° to +1600°F (−196° to +871°C), in both Fahrenheit and Celsius units and with both temperature and electromotive force as arguments. A.

536.631

4476. The librational heat capacity of ice and of heavy ice. R. W. BLUE. *J. chem. Phys.*, **22**, 280–3 (*Feb.*, 1954).

Interpretation of the heat capacities of crystals is difficult when polyatomic molecules or ions are involved, owing to the variation with temperature of the translational heat capacity, arising from intermolecular vibrations, in the same regions in which rotational and vibrational heat capacities are also varying with temperature. It is shown how translational and rotational heat capacities may be studied separately in the case of ice where the heat capacities of both H_2O and D_2O have been measured. Moments of inertia are nearly doubled by substitution of D for H, while the molecular weight is increased by only 10%. Thus the effect of isotopic substitution is relatively large on the rotational heat capacity as compared to the translational heat capacity. A.

536.631 : 537.311.33 : 538.221

4477. Some physical properties of nickel oxides. Y. SHIMOMURA AND I. TSUBOKAWA. *J. Phys. Soc. Japan*, **9**, 19–21 (*Jan.–Feb.*, 1954).

Variation of the magnetic susceptibility, electric resistivity and specific heat with temperature have been observed for various nickel oxides containing different amounts of copper. The anomaly temperatures of these properties and also of their lattice generally differ from one another. Among these temperatures the last is the lowest and the magnetic the highest, and the higher the copper content the larger the difference. It may be concluded from these results that the deformation of nickel oxide must be due to the antiferromagnetic exchange interaction as proposed by Greenwald and Smart, but at the same time it seems to be affected by other factors, e.g. the ionic radius ratio and the vacancies. A.

536.631 : 538.114

4478. The heat capacity of gadolinium from 15 to 355°K. M. GRIFFEL, R. E. SKOCHDOPOLE AND F. H. SPEDDING. *Phys. Rev.*, **93**, 657–61 (*Feb.* 15, 1954).

An enhanced heat capacity associated with the ferromagnetic transition was observed, with maximum at 18·6°C. The thermodynamic functions were computed and are tabulated for various temperatures. The results are discussed in connection with theories of ferromagnetism. A.

536.631 : 538.22

4479. Thermal anomalies associated with the antiferromagnetic ordering of FeF_2, CoF_2 and NiF_2. J. W. STOUT AND E. CATALANO. Letter in *Phys. Rev.*, **92**, 1575 (*Dec.* 15, 1953).

Reports specific heat measurements between 12° and 300°K, λ-points being observed at 78·3°, 37·7° and 73·2°K respectively, the antiferromagnetic Curie points of the substances. E. P. WOHLFARTH

536.631 : 539.31 : 539.11

The vibrational spectrum and the specific heat of germanium and silicon. *See Abstr.* 4773

536.654

4480. The heat of sublimation of graphite and the composition of carbon vapor. G. GLOCKLER. *J. chem. Phys.*, **22**, 159–61 (*Feb.*, 1954).

The total vapour pressure of graphite is calculated as a function of temperature to the harmonic oscillator-rigid rotator approximation. It is assumed that three species (C_1, C_2, and C_3) are present in the gas. The C_1 atoms are most prominent in the mixture. C_3 molecules are relatively more abundant than C_2 diatoms. The heats of sublimation of the various carbon species are discussed. A.

THERMODYNAMICS 536.7/.8

536.7

4481. The thermodynamics of irreversible processes and the theory of phases. K. POPOFF. *C.R. Acad. Sci.* [*Paris*] **238**, 331–3 (*Jan.* 18, 1954) *In French.*

The results of a previous investigation [Abstr. 1270 (1954)] are applied to a system of two components and two phases, the second of which contains only one component. F. E. HOARE

536.7

4482. The thermodynamic properties of gaseous titanium. H. G. KOLSKY AND P. W. GILLES. *J. chem. Phys.*, **22**, 232–3 (*Feb.*, 1954).

Tables of the thermodynamics properties of titanium considered as an ideal monatomic gas were calculated using the Los Alamos Scientific Laboratory IBM 701 Computer for a temperature range 0 to 8000°K. A.

536.722

4483. Thermodynamics of propulsion gases in atomic rockets. I. SÄNGER-BREDT. *Z. Naturforsch.*, **8a**, 796–804 (*Dec.*, 1953) *In German.*

In some technical fields, e.g. in thermal rockets heated by nuclear energy, the problem arises how to accelerate to a high outflow velocity a working s stance, heated to very high enthalpy, without exceed the limiting heat transfer conditions at the bo walls. The author investigates the thermodyna properties and outflow velocity of hydrogen in region 10^{-5} to 10^2 atm. pressure and up to 10 00 temperature. The quantitative results show that flow velocities of about 30 000 m/sec can be achie An approximate calculation for helium yields hig exit velocities under similar convective heat tran conditions in the region of moderate enthalp However, above outflow velocities of 10 000 m/ the conditions become less favourable than hydrogen, owing to the much higher gas temperatu T. P. BR

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.

537.2

4484. The modern theory of potential. M. BREL *Ann. Inst. Fourier.*, **4**, 113–40 (1954) *In French.*

A review, with bibliography of 53 of the m important items.

537.222 : 621.38 : 621.3.01

4485. Space-charge between parallel planes. P. COPELAND AND L. M. SACHS. *Amer. J. Phys.*, 2 102–7 (*March*, 1954).

The problem of the potential distribution betwe two parallel planes at the same potential as a functi of the current density passing between the planes analysed by successive approximation resulting power series. The method involves a considerati of the influence of space-charge on transit time, a the leading terms of the Maclaurin's series expressi for the transit time in powers of the current densi are evaluated.

537.226

4486. Onsager's theory of the dielectric constant polar liquids. R. O. DAVIES AND B. K. SCAIF Letter in *J. chem. Phys.*, **22**, 148–9 (*Jan.*, 1954).

Onsager's formula for the dielectric constant compared with that of Piekara [Abstr. 7968 (195 and is found to be a correct deduction from the mod used by both these authors. R. O. DAVI

537.226

4487. Dipole moments and correlation parameters binary mixtures of organic substances. M. JOERGE HEYDEN, A. NIKURADSE AND R. ULBRICH. *Naturforsch.*, **9a**, 38–49 (*Jan.*, 1954) *In German.*

Formulae for the calculation of the dipole momen in binary mixtures are deduced from the gener theory of electrical polarization and Kirkwood theory. Evaluation of correlation parameters (C from measurements of dipole moments on a numb of binary mixtures of organic substances, in whic strong self-association is absent, shows that the C is not characteristic of the intermolecular exchan

rces, but that reduced correlation parameters (RCP) fined for infinite dilution of one component in the her, is. The values calculated for chloro compounds admixture with non-halogenated compounds are eater than predicted either by Kirkwood [*J. chem. ys.*, **7**, 911–19 (*Oct.*, 1939)] or Harris and Alder's bstr. 6030 (1953)] theories. R. C. MURRAY

537.226.1.08

88. Supplement to the method of measurement of e dielectric constant of gases in the hyperfrequency gion. A. GOZZINI AND E. POLLACO. *C.R. Acad. i. [Paris]* **237**, 1652–4 (*Dec.* 21, 1953) *In French.*

Improvements to the apparatus described in bstr. 3445 (1954). D. H. WHIFFEN

537.226.1.08

89. Precise measurement of complex dielectric nstants of liquids by voltage resonance. C. ABGRALL. *.R. Acad. Sci. [Paris]* **237**, 1650–2 (*Dec.* 21, 1953) *In ench.*

Brief details of a method in which capacity and sistance changes are obtained by moving a piston rough the liquid and compared with an air condenser d resistance, using a voltmeter to indicate resonance. D. H. WHIFFEN

537.226.2

490. Dielectric properties of some double tartrates. . JONA AND R. PEPINSKY. Letter in *Phys. Rev.*, **92**, 577 (*Dec.* 15, 1953).

Following recent conflicting statements on the ielectric behaviour of certain double tartrates, the uthors have measured the dielectric constants along he *a*, *b* and *c* axes of $NaRbC_4H_4O_6 . 4H_2O$ over the mperature range 4·2°K to 333°K. No dielectric nomaly was observed, contrary to Mueller's statement. The dielectric behaviour of $NaNH_4C_4H_4O_6 . H_2O$, however, exhibited an anomaly between 105° nd 110°K; the dielectric constants along the 3 axes ecreased suddenly by about 17%, suggesting a otational transition. H. J. H. STARKS

537.226.2

491. The dielectric constant of supercritical steam. K. FOGO, S. W. BENSON AND C. S. COPELAND. *chem. Phys.*, **22**, 209–12 (*Feb.*, 1954).

A description is given of the method used to easure the dielectric constant of steam at densities etween 0·2 and 0·4 g/cm³ in the temperature range 77 to 395°C. Smoothed values of the dielectric onstant are tabulated at 378, 383, 388 and 393°C for ensities from 0·1 to 0·5 g/cm³. A.

537.226.2

492. Dielectric properties of hydrogen halides. I. Hydrogen chloride. R. W. SWENSON AND R. H. OLE. *J. chem. Phys.*, **22**, 284–8 (*Feb.*, 1954).

For Pt I, see Abstr. 1289 (1954). Dielectric conant and loss measurements have been made for quid and solid hydrogen chloride in the temperature ange 63–190°K and frequency range 20 c/s to 10^6 c/s. he dielectric constants of the liquid and disordered olid phase stable above 99°K are described quite ccurately by Onsager's equation. Below 99°K a slight dispersion with activation energy of 2·6 kcal/mol is found with dielectric constants in the range 3·7–4·3. Special precautions against sample inhomogeneity were necessary; these and various residual effects are discussed. A.

537.226.2 : 621.3.011.22 : 621.315.613.1

4493. Electrical properties of Indian mica. V. D.C. resistivity. S. S. MANDAL AND P. C. MAHANTI. *Indian J. Phys.*, **27**, 294–304 (*June*, 1953).

For Pt IV, see Abstr. 1760 (1952). Gives the results of measurement of volume and surface resistivities of different qualities of the more abundant red and green Indian muscovite mica and the effect of humidity, temperature and preheating on them. A.

537.226.2 : 535.371

Dielectric constant measurements on doubly activated phosphors. *See Abstr.* 4400

537.226.2 : 621.3.011.5 : 621.315.616.9

4494. The dielectric properties of phenol formaldehyde resin. E. RUSHTON. *Rep. Brit. Elect. Res. Assoc., Ref. L/T*273, 11 *pp.* (1952).

The dielectric properties of pure phenol formaldehyde resin of the thermosetting type were measured as a function of frequency over the range 50 c/s to 24 000 Mc/s. A.

537.226.2 : 621.3.011.5 : 621.315.616.9

4495. The dielectric properties of polytetrafluorethylene and polychlortrifluorethylene. J. V. L. PARRY. *Rep. Brit. Elect. Res. Assoc., Ref. L/T*275, 8 *pp.* (1952).

An investigation is described of the electrical properties over the frequency range 100 c/s to 25 000 Mc/s and at various temperatures. The variation of the spread of relaxation times (with temperature), and of the maximum value of power factor are in excellent agreement with the extension of Debye's relations derived by Fröhlich. A.

537.226.2 : 548.7

Ferroelectricity and crystal structure. *See Abstr.* 5119

537.226.2 : 621.3.011.5 : 621.315.612.4

4496. Ferro-electric properties of some crystals. G. A. SMOLENSKIĬ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 5, 985–7 (1952) *In Russian.*

Results are given and discussed of an investigation on the temperature-dependence of permittivity of $SrTiO_3$, $CdTiO_3$, $PbTiO_3$ and $PbZrO_3$ in the temperature range of 2–300 (or 500)°K. Static tests of the piezoelectric properties of polycrystalline specimens of solid solutions $BaTiO_3$–$BaZrO_3$ have shown that, as the proportion of the latter increases, the piezo-modulus of these solutions first decreases, then increases, to decrease again as the concentration of $BaZrO_3$ becomes still larger. The piezo-modulus of $PbZrO_3$ at room temperature is much less than that of $BaTiO_3$; the experiments have not confirmed the change of sign of piezo-polarization, to be expected for $PbZrO_3$ from thermodynamic considerations. The tetragonal structure for $PbZrO_3$ is to be rejected, and the previously accepted [Abstr. 4952 (1950)] orthorhombic structure seems to meet the case better. F. LACHMAN

537.226.2 : 677 : 621.317.335.3

4497. Moisture-sensitivity of dielectric constant of jute and cotton. B. L. BANERJEE. *Indian J. Phys.*, **27**, 223–34 (*May*, 1953).

The effect for both raw and chemically treated forms was studied. The moisture-sensitivity of the dielectric constant differed for both materials, but when dry they have sensibly the same value of dielectric constant. Attempts are made to explain this difference. A.

537.226.2 : 536.424

4498. Phase transitions in ferroelectric $KNbO_3$. G. SHIRANE, H. DANNER, A. PAVLOVIC AND R. PEPINSKY. *Phys. Rev.*, **93**, 672–3 (*Feb.* 15, 1954).

It is shown that ferroelectric $KNbO_3$ undergoes another phase transition at $-10°C$ in addition to two phase transitions previously reported at 225° and 435°C. At this lowest phase transition $KNbO_3$, on cooling, changes its orthorhombic structure to a rhombohedral one, and this change is accompanied by a sharp change of the dielectric constant. The specific heat anomalies at three transitions were measured, and the results are compared with the case of $BaTiO_3$. A.

537.226.2 : 548.0 : 621.315.612.4

4499. Mutual transformations of the $BaTiO_3$ single crystals. N. S. NOVOSIL'TSEV AND A. L. KHODAKOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 6, 1263–8 (1952) *In Russian.*

Presents the results of an investigation into the effect of heat treatment on the temperature-dependence of the permittivity of $BaTiO_3$ crystals, and the possibility of mutual transformation between different crystal forms. The heat treatment temperatures used were 1000, 1100, 1200 and 1300°C. The ε/t graph and the tables of $\tan\delta$ and of the Curie point are given, the two tabulated magnitudes decreasing as the temperature of heat treatment decreases. It was found that crystals heat-treated at 1300 and 1200°C have a tetragonal, and those treated at 1000°C or untreated a cubic structure, whereas crystals heat-treated at 1100°C give a blurred X-ray picture. F. LACHMAN

537.226.2

4500. Ferroelectric properties of $BaTiO_3$–$PbZrO_3$ solid solutions. G. A. SMOLENSKIĬ, A. I. AGRANOVSKAYA AND N. N. KRAĬNIK. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 1, 55–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF–tr*-81.

In the solid solutions studied both the divalent and tetravalent cations are replaced simultaneously. The temperature dependence of the dielectric constant in weak fields and the thermal linear expansion were determined. The results are discussed in terms of the statistical distribution of the four components $BaTiO_3$, $BaZrO_3$, $PbTiO_3$, $PbZrO_3$ in the lattice.

C. A. HOGARTH

537.226.2 : 621.315.612.4

4501. Barium titanate dielectrics. Their structure and their special dielectric behaviour. W. SOYCK. *Schweiz. Arch. angew. Wiss. Tech.*, **19**, 316–22 (O[illegible] 1953) *In German.*

Describes the development, manufacture and el[illegible] trical characteristics of barium-titanate-type capacito[illegible] Temperature and ageing characteristics are discuss[illegible] also the variation of permittivity with field stren[illegible] and frequency of the applied voltage. J. H. MAS[illegible]

537.22[illegible]

4502. Effect of a two-dimensional pressure on [illegible] Curie point of barium titanate. P. W. FORSBERGH, *Phys. Rev.*, **93**, 686–92 (*Feb.* 15, 1954).

By hydraulic means, a single crystal of bari[illegible] titanate in the shape of a flat circular disk was s[illegible] jected to a pressure exerted on its edges and not [illegible] its faces. A very slight pressure removed all doma[illegible] that were not normal to the disk. The stress syst[illegible] then consisted of equal pressures on the two a a[illegible] and no pressure on the c axis. The transition te[illegible] perature increased with the square of the tw[illegible] dimensional pressure, while, according to Merz[illegible] hydrostatic pressure produces a linear drop. Us[illegible] Devonshire's expansion for the free energy and [illegible] appropriate Legendre transformation, the free ener[illegible] depending on polarization and pressure, was obtain[illegible] for both two-dimensional and hydrostatic str[illegible] systems. This yielded a purely linear-press[illegible] dependence, and it was, therefore, necessary to supp[illegible] ment Devonshire's expansion with higher terms [illegible] order to obtain a quadratic effect. Although it w[illegible] too difficult to evaluate the effect of pressure on t[illegible] transition temperature itself when higher terms w[illegible] included, it was easy to determine the effect on t[illegible] Curie–Weiss temperature T_0. This is the temperatu[illegible] at which the inverse susceptibility of the cubic pha[illegible] extrapolates to zero, and its pressure dependence w[illegible] be the subject of a future paper. For both tw[illegible] dimensional and hydrostatic pressures, the linear pr[illegible] of the shift of the Curie–Weiss temperature was fou[illegible] to depend only on the lower terms in the free energ[illegible] and provide two independent relations for det[illegible] mining the two g coefficients. The quadratic shift [illegible] the Curie–Weiss temperature depends on the high[illegible] terms with which Devonshire's expansion w[illegible] supplemented, and a reasonable interpretation [illegible] these higher terms gave an upward direction to t[illegible] quadratic shift of the Curie–Weiss temperature.

537.226.2 : 548.736

X-ray study of phase transitions in $PbZrO_3$ conta[illegible] ing Ba or Sr. *See Abstr.* 5161

537.226

4503. A simple calculation of dielectric loss fro[illegible] dielectric dispersion for polar polymers. P. EHRLIC[illegible] *J. Res. Nat. Bur. Stand.*, **50**, 19–21 (*Jan.*, 1953).

For polar polymers undergoing orientation it [illegible] possible to calculate dielectric losses from dielectri[illegible] constant data by use of a single approximation alrea[illegible] familiar from its application to mechanical properti[illegible] if this approximation is applied to the real part of t[illegible] dielectric constant only and if data over a sufficient[illegible] wide frequency range are available. Data obtain[illegible] at frequencies from 10^2 to 10^8 c/s for Butvar and for[illegible] copolymer of styrene and methyl methacrylate a[illegible] analysed and it is found that observed and calculat[illegible] values of the dielectric losses agree within 10% [illegible] better.

537.226.3 : 539.11

4504. Hertzian spectrum and structure of solids. II. Preliminary researches on non-stoichiometric compounds: oxides of uranium. M. FREYMANN, S. LANGEVIN, M. T. ROLLAND-BERNARD, P. PERIO AND R. KLEINBERGER. *J. Phys. Radium*, **15**, 82–91 (*Feb.*, 1954) *In French.*

Contains values of ε'' from 100–300°K, 2 kc/s to 3 Mc/s and 9560 Mc/s for various compositions from UO_3 to UO_2. A low-temperature Debye type of loss connected with lattice defects is observed and has activation energies from 2–4 kcal/mole. There is also a high-temperature ionic and electronic conduction region which shows hysteresis effects. D. H. WHIFFEN

537.226.3 : 539.132

4505. Dielectric losses in polar molecules with several internal rotation axes. G. KLAGES. *Z. Phys.*, **136**, *No.* 4, 480–90 (1953) *In German.*

The distribution of times of relaxation is calculated for ellipsoidal molecules, in which the dipole can orient itself in the field by rotating about the three internal axes. This represents a first approximation using mean motions of the polar groups and the whole molecule. A comparison is made with measurements in the long wavelength region of dipole absorption for chain molecules; the success suggests that mean motion of polar groups in more complicated molecules can be predicted in this way. J. JACOBS

537.226.31

4506. Influence of chemical treatment on the Hertzian absorption of zinc oxide. R. ROHMER AND M. TIENNOT. *C.R. Acad. Sci.* [*Paris*] **238**, 234–6 (*Jan.* 11, 1954) *In French.*

Tan δ *v.* T curves at 10 kc/s differ widely according to the method of preparation. D. H. WHIFFEN

537.226.32 : 621.319

4507. Studies of the heterocharges of electrets. S. WIKSTRÖM. *Ark. Fys.*, **7**, *Paper* 20, 213–20 (1953). Also in *Ericsson Tech.*, **9**, *No.* 2, 225–34 (1953).

Heterocharged electrets of carnauba wax have been studied from the following points of view: The dependence of the charging and discharging rate on temperature; influence of a d.c. field at room temperature on a prepared electret; influence of pressure during charging and discharging; influence of polarization on the a.c. capacitance and loss angle. A.

537.226.33 : 548.7

4508. Calculation of the distribution of relaxation times for a single-axis rotator using the random jump hypothesis. J. D. HOFFMAN. Letter in *J. chem. Phys.*, **22**, 156–7 (*Jan.*, 1954).

A similar theory to that of Abstr. 3454 (1954) is applied to a model in which the new orientation of a molecule is random after its rotational jumps and the results are compared. D. H. WHIFFEN

537.226.33 : 621.315.615

4509. On the phenomena of relaxation in dielectric liquids. U. TIBERIO. Letter in *Alta Frequenza*, **22**, 295–302 (*Dec.*, 1953) *In Italian.*

The two chief experimental problems are discussed. These are: the variation of the conductivity and permittivity with frequency of an alternating current; the variation of conductivity with field strength under direct voltage. A continuous flow apparatus is described in which liquid passes through a very small gap between two insulated cylinders. By applying voltage across the cylinders a high field strength can be set up in the gap. Electrolytic effects are confined to the walls of the cylinders. By operating at a pressure of 200 atmospheres the transit time of the fluid across the gap may be reduced to 3 μsec. The temperature rise using a pulsed field (10 μsec and 10^6 V/m) is 0·06°c. Curves are presented of conductivity *v.* field strength for distilled water, metal salts and an emulsion. Circuits are shown for several oscillographic methods. S. C. DUNN (R)

537.226.33.08

4510. A precise method of studying the distribution of electrical relaxation time with application to water. H. SCHWAN. *Z. Naturforsch.*, **9a**, 35–7 (*Jan.*, 1954) *In German.*

A generalized form of the Cole–Cole [*J. chem. Phys.*, **9**, 341–51 (*April*, 1941)] formula for the relaxation time distribution function is derived. Experimental results obtained with wavelengths between 30 and 200 cm in distilled water are compared with the theoretical values. C. G. MORGAN

537.226.8.08 : 621.317.333.6

4511. Test cell for measuring the dielectric strength of elastomeric materials in air. S. I. REYNOLDS. *Rev. sci. Instrum.*, **25**, 177–9 (*Feb.*, 1954).

A special test cell using standard ASTM electrodes is described for measuring the dielectric strength of small specimens of elastomeric materials in air, up to a peak voltage of 50 kV. The test cell is constructed so that samples can be measured in a stretched or unstretched state. A dial micrometer automatically measures the thickness of the samples in test position. Results of alternating current tests on GRS electrical grade rubber are given. A.

537.228.3 : 535.55

Electro-optic properties of zinc blende [ZnS]. *See Abstr.* 4438

537.29 : 536.24

The effect of electric fields on the heat transfer of gases. *See Abstr.* 4452

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.1

4512. A note on the formula for the mobility of electrons with mean free path varying with velocity. P. M. DAVIDSON. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 159–61 (*Feb.*); Erratum, 279 (*March*, 1954).

The simple mobility formula for the case when the mean free path is constant is often erroneously generalized for the case when it varies with velocity. The correct generalization is derived and its physical significance is discussed. P. M. DAVIDSON

537.311.1

4513. Justification of the use of perturbation theory in metallic conductivity. J. S. VAN WIERINGEN. *Proc. Phys. Soc.* [*London*] *A*, **67**, 206–16 (*March*, 1954).

In metals at high temperatures the time τ spent by an electron between two consecutive scatterings is

smaller than the duration of the collision t_c, if one defines t_c as that time after which one can be sure that the interaction with the scattering centre (or lattice wave) is less than kT. Hence the customary theory of conductivity is not justified *a priori* because it considers the scatterings to be independent. Yet its results are confirmed by experiment. In this paper the correction terms for scattering by two centres are calculated. They are shown to be negligible for a Fermi gas. A.

537.311.1 : 548.7

On the interaction of additive electrons with polarization in ionic crystals. *See Abstr.* 5123

537.311.1 : 550.38

Electron inertia and terrestrial magnetism. *See Abstr.* 5172

537.311.3.08 : 621.317.331.089.6

4514. The correction of an error in the determination of high resistances by capacitor discharge. G. C. CURTIS. *Brit. J. appl. Phys.*, **5**, 106–8 (*March*, 1954).

When determining the surface resistivity of hard-glass and silica rods from observations of the discharge of a Wulf electrometer, it was found that the voltage decay was initially non-exponential. This is attributed to the effect of capacitance between rod and case, distributed along the length of the rod. The effect is treated mathematically and it is shown that, even if the resistance is determined from the exponential portion of the curve, a correction is required. A formula for the correction and an approximate method of applying it are given. An indication is given of the circumstances in which values of resistance determined by the leakage method, might require appreciable correction. A.

537.311.31

4515. Electric conductivity of metals at high current density. E. S. BOROVIK. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 771–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-140.

Bi, Pt, W and Cu have been studied at current densities $\sim 10^6$ amp/cm^2, using constant-current and pulse methods. The corrections to be applied for resistance changes due to heating and to the magnetic field of the current are discussed, and it is concluded that Pt, W and Cu show no deviations from Ohm's law, but that in Bi the increase in resistance from this cause reaches 30–40%. E. H. SONDHEIMER

537.311.31 : 536.424 : 539.219

4516. On electrical resistivity changes in low temperatures of antimony and thallium alloys. E. KURZYNIEC. *Bull. internat. Acad. Polon. Sci. A*, *No.* 3–6, 159–68 (*March–June*, 1951).

The Sb.Tl equilibrium diagram is investigated by measuring the ratio r of resistivity of alloys at 0°c and liquid N_2 or H_2 temp. Breaks in the curve of r against composition indicate phase changes. The specimens were all quenched from 180°c and a phase diagram which is in accord with this and with other work is drawn. The four phases which occur are solutions of Sb in αTl and in βTl, a compound Tl_2Sb_7, and Tl dissolved in Sb. W. M. LOMER

537.311.32 : 541.183.26

Effect of adsorption on the resistance of active carbon. *See Abstr.* 5091

537.311.

4517. Contribution to the theory of conduction semiconductors. W.-H. ISAY. *Ann. Phys.* [*Leipz*. **13**, *No.* 6–8, 327–48 (1953) *In German.*

The determination of parameters (impurity co centration, etc.) from observed transient currents investigated. Exact solutions of the different equation for a simple model are too restricted f practical use. A method of approximation is d veloped which permits correlation with experiment results, and which is extended to include sen conducting phosphors. F. ANSBACHER

537.311.

4518. The theory of magnetic effects in isotrop semiconductors having high mobility. O. MADELUN *Z. Naturforsch.*, **8a**, 791–5 (*Dec.*, 1953) *In German.*

For a previous discussion see Abstr. 6039 (1953 It is shown that for a mixed semiconductor the Ha coefficient is strongly field-dependent and may chang sign in high enough fields. The change of resistanc in a transverse magnetic field tends to a saturation value with increasing field strength. Application made to InSb. E. P. WOHLFART

537.311.33 : 537.312.

4519. The electron-voltaic effect in p–n junction induced by beta-particle bombardment. P. RAPPAPORT Letter in *Phys. Rev.*, **93**, 246–7 (*Jan.* 1, 1954).

Si and Ge thin wafers were bombarded from the sid opposite to the alloy region. The effects are similar to those with a photo-voltaic cell, except that the particles penetrate further into the semiconductor than absorbed light does. C. A. HOGARTH

537.311.33

4520. Current noise in thermistor bolometer flakes J. J. BROPHY. *J. appl. Phys.*, **25**, 222–5 (*Feb.*, 1954).

The characteristics of the additional electrical noise generated by iron oxide thermistor bolometer flakes due to direct current passing through the units is investigated. It is found that the noise is similar to the current noise observed in other semiconductors. The current noise power density is observed to depend inversely upon frequency, to be approximately proportional to the direct current, and to be independent of temperature. It is indicated that the major source of the noise is at the electrodes which make electrical contact to the semiconductor. Electrodes produced by evaporated gold applied through a potential difference yield relatively low noise flakes. A.

537.311.33 : 535.376

The electroluminescence of semiconducting phosphors. *See Abstr.* 4417

537.311.33 : 621.315.59

4521. Note on the Johnsen–Rahbeck effect. D. MAYER. *Elektrotech. Obzor*, **42**, *No.* 5, 257–62 (1953) *In Czech.*

This effect consists of the strong adhesion of two plane electrodes to the smooth surfaces of a semiconductor placed between them when a d.c. voltage of the order of 100 V is applied. The effect is explained on the basis of the theory of semiconductors and experiments for measuring it are described at length. H. NOREL (R)

537.311.33 : 621.372.413 : 621.315.59

4522. A resonant cavity study of semiconductors. H.-T. Hsieh, J. M. Goldey and S. C. Brown. *J. appl. Phys.*, **25**, 302–6 (*March*, 1954).

A solution of Maxwell's equations is obtained in a resonant cavity with a centre post of arbitrary electrical properties. The solution gives the dielectric coefficient and the conductivity of the centre post in terms of the natural frequency and Q of the cavity. The theory is of particular use in the study of semiconductors where perturbation theories are of little value. It is shown that a transition from a cylindrical mode to a coaxial mode occurs as the conductivity of the centre post is varied. This transition occurs for a relatively small change in conductivity. The present results are compared with those of perturbation theory, and it is shown that the latter are valid over a greater range than the conditions imposed in their derivation indicate. A.

537.311.33

4523. Semiconducting properties of boron. J. Lagrenaudie. *J. Chim. phys.*, **50**, 629–33 (*Nov.–Dec.*, 1953) *In French.*

The reflectivity of boron in the visible and extending to 1 μ is approximately constant and of order 0·29. The absorption edge is near 1 μ. The optical refractive index and dielectric constant ε are 3·25 and 10·6, and the 0·5 Mc/s value of ε is 12. Studies with the electron microscope suggest various crystal arrangements of B depending on the mode of preparation. The limit of photoconductivity is between 1·1 and 1·3 μ, the precise value depending on the actual specimen. C. A. HOGARTH

537.311.33 : 548.7

4524. On the influence of oxygen on the conductivity of CdS single crystals. W Muscheid *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 305–21 (1953) *In German.*

Vacuum heat treatment of CdS crystals causes a very large increase in the dark conductivity and this is related to a reduction in the effects due to oxygen in the crystals before heating. Measurements of the temperature variation of both dark and photoconductivity in the region 300 to 700°K are given and these depend in a characteristic manner on the previous treatment of the specimens. A "disorder" model is developed to explain the results. C. A. HOGARTH

537.311.33 : 537.312.6

4525. The electrical conductivity of cuprous oxide. A. I. Andrievskiĭ, V. I. Voloshchenko and M. T. Mishchenko. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 4, 521–3 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-90.*

Study of the electrical conductance of Cu_2O layers as a function of time after vacuum or oxygen tempering at temperatures around 1000°C. Tempering at the higher temperatures in O_2 produces fewer grains in the layers and causes a decrease in conductance. The specific conductivity is proportional to the number of grains per unit surface area of the sample. C. A. HOGARTH

537.311.33

4526. On the effective mass of the conduction electron in germanium. W. Sasaki and M. Kuno. Note in *J. Phys. Soc. Japan*, **8**, 791–2 (*Nov.–Dec.*, 1953).

Results of measurements of the temperature variation of Hall constant and conductivity, and hence mobility are given for n-type Ge. From the results the thermoelectric power of Ge is calculated and made to fit experimental measurements by adjusting the value for effective mass. C. A. HOGARTH

537.311.33 : 537.312.5 : 538.63

4527. Contribution to the study of the photomagneto-electric effect in germanium. H. Bulliard. *Ann. Phys.* [*Paris*] **9**, 52–83 (*Jan.–Feb.*, 1954) *In French.*

When one face of a semiconductor is illuminated and a magnetic field is applied parallel to the face illuminated, a potential difference is developed in the other direction perpendicular to the field. A theoretical treatment of this effect is given and experimental results are presented in confirmation. The dependence of the effect on wavelength, intensity of light and the magnetic field are considered. A method of measuring the volume recombination coefficient for holes and electrons, and also the surface recombination velocity, is suggested by the results obtained on Ge samples. Since no current flows in the photomagneto-electric effect, the noise level is much smaller than for the associated photo-resistance effect. A. E. DE BARR

537.311.33

4528. Some electrical properties of germanium crystals containing compensated impurities. V. Ozarow. *Phys. Rev.*, **93**, 371–2 (*Feb.* 1, 1954).

Compensated n-type germanium crystals containing both radioindium and radioantimony were prepared. The indium and antimony content was determined by radiochemical procedures. The Hall constant R and resistivity ρ of three compensated samples and one uncompensated sample of room temperature resistivity comparable to that of one of the compensated samples were measured in the temperature range 78°K to 393°K. The Hall mobility μ was calculated as R/ρ and compared with theoretically calculated values of μ. A.

537.311.33 : 538.632

4529. Electrical properties of n-type germanium. P. P. Debye and E. M. Conwell. *Phys. Rev.*, **93**, 693–706 (*Feb.* 15, 1954).

Measurements of conductivity and Hall effect from 11°K to 300°K on a set of n-type germanium samples covering the range from intrinsic to degenerate are reported. The purity and uniformity of the samples and extensiveness of the data permit a more thoroughgoing comparison with theory than has been possible in previous work. The theory of mobility is reviewed briefly. The treatment of impurity scattering by Brooks and Herring is presented, and their formula for the impurity mobility is used throughout. An analytical formula for obtaining the mobility from lattice and impurity mobilities is included. The effect of electron-electron collisions on the mobility is considered in a qualitative manner. The principal conclusions concerning the mobility are as follows: (1) Over the range 20·4°K to 300°K the lattice mobility varies as $T^{-1.64}$ rather than the theoretically predicted $T^{-1.5}$. (2) The impurity mobility increases with temperature less rapidly than the theoretical formula

predicts, the exponent of T in the numerator being apparently between 1·0 and 1·5. (3) The Erginsoy formula for neutral impurity scattering appears to fit the experimental data reasonably well for a value of effective mass about one-third the free electron mass. (4) Dislocation scattering is negligible, leading to the conclusion that the density of edge-type dislocations is less than $10^6/cm^2$. In fitting the concentration data, the parameters involved are activation energy, acceptor concentration and effective mass. An effective mass in the neighbourhood of one-quarter the free electron mass gives the best fit for all samples. The values of acceptor concentration obtained in this way for this effective mass agree well with those calculated from the low-temperature mobility values. The activation energy obtained for the purer samples is 0·0125 eV, in agreement with the value calculated from the hydrogen-like model for one-quarter the free electron mass. The variation of activation energy with concentration does not agree with that observed by Pearson and Bardeen for p-type silicon. The effects which have been proposed to explain the variation are: residual potential energy of attraction between free electrons and ionized donors, screening of trapping centres by the free electrons, polarization of neutral centres by free electrons. It is concluded that a combination of the three effects will probably be required to explain the results. The ratio of Hall to drift mobility is shown to agree with the theoretically predicted value within about 10% in the range 78°K to 300°K. A.

537.311.33 : 535.343.2–15 : 537.312.5

4530. Infrared absorption, photoconductivity, and impurity states in germanium. W. Kaiser and H. Y. Fan. *Phys. Rev.*, **93**, 977–80 (*March* 1, 1954).

Infrared absorption and photoconductivity in p-type germanium with gold and copper impurities have been investigated at different temperatures. Photoconductivity in gold-doped germanium at liquid nitrogen and liquid helium temperatures shows a long-wavelength tail beyond the fundamental absorption edge, which falls off sharply at about 6 microns corresponding to 0·21 eV. This value agrees well with the acceptor activation energy determined by electrical measurements. For copper-doped germanium at low temperatures both absorption and photoconductivity show a maximum at about 22 microns corresponding to 0·055 eV. This value also agrees with the acceptor activation energy given by Hall-effect measurements. At room temperature more absorption is found in the region 2 to 5 microns as compared to p-type germanium doped with indium and aluminium. This is likely to be due to photoionization from a deeper level 0·25 eV above the valence band. A.

537.311.33 : 539.373

Conductivity of plastically-deformed germanium. *See Abstr.* 5043

537.311.33

4531. Occurrence of natural p–n junctions in lead selenide. A. E. Goldberg and G. R. Mitchell. *J. chem. Phys.*, **22**, 220–2 (*Feb.*, 1954).

Single crystals of PbSe were grown from melts in sealed quartz tubes. Except for a very narrow range of intial melt compositions, stoichiometric excesses of Pb or Se in the melt resulted in crystals that were wholly n or p type, respectively. Initial compositions within the critical range yielded crystals showing both p and n regions. The electrical resistivities were related to crystal compositions permitting the construction of the Pb–Se phase diagram in a narrow region about the compound PbSe. The invariant melting point for the system falls in the Se-rich region. This precludes the possibility of growing a crystal from a melt which is of stoichiometric composition throughout. A.

537.311.33

4532. Electrical characteristics of MnSe and MnTe. W. Palmer. Letter in *J. appl. Phys.*, **25**, 125 (*Jan.*, 1954).

For MnSe at 0°C resistivity (ρ) $\simeq 3\times10^3$ Ω.cm, activation energy between 0·07 and 0·13 eV decreasing with temperature (T). Hall coefficient (R) and magneto-resistance were not measurable. For MnTe $\rho \simeq 1$ Ω.cm at 0°C, and increases with T, and R varies from $+0{\cdot}6$ to $2{\cdot}6\ cm^3/C$ in the range investigated (20°C to −196°C). Both types show hysterisis for ρ *v.* T. Specimens were about 1 mm dia. F. ANSBACHER

537.311.33 : 538.221 : 536.631

Resistivity of nickel oxides. *See Abstr.* 4477

537.311.33

4533. Frequency dependence of the electrical conductivity of polycrystalline selenium. H. Gobrecht and H. Hamisch. *Z. Phys.*, **136**, *No.* 2, 234–47 (1953) *In German.*

Measurements were made on layers of Se evaporated on to glass slides at temperatures of 86°C or 55°C and annealed at ~200°C. At high frequency the conductivity increases by 50–200% compared with the low-frequency value. The results follow the Maxwell–Wagner theory for double layer capacities. The activation energy obtained from the temperature variation of conductivity is only slightly dependent on frequency. G. F. J. GARLICK

537.311.33

4534. Very high frequency conductivity of hexagonal selenium. H. Rebstock and K. Seiler. *Z. Naturforsch.*, **9a**, 49–55 (*Jan.*, 1954) *In German.*

In a concentric cavity, the 40 cm conductivity of Se rods of varying length and iodine content, made by heat treating at 217°C, was measured. By contrast with d.c. measurements the iodine had little or no effect on the conductivity. The crystal growth as promoted by the addition of iodine was studied by electron microscopy and showed that halogenized specimens transform more readily than pure ones. The recrystallization of the interior of the crystal which is related to the heat-treating time for minimum resistance is helped by the addition of iodine. C. A. HOGARTH

537.311.33

4535. Researches on the mechanism of the electrical conductivity of grey tin. G. Busch and J. Wieland. *Helv. phys. Acta*, **26**, *No.* 7–8, 697–730 (1953) *In German.*

Experiments on the temperature and magnetic field variations of conductivity, Hall constant and magneto-resistive effect are described. Magnetic fields up to

16 000 oersted were employed. Specimens with various significant impurities were employed and although specimens have only been prepared in powder form, the theory developed by the authors, particularly as regards the temperature variation of Hall mobility, enables a value for the true conductivity to be estimated. C. A. HOGARTH

537.311.33 : 541.128

4536. Electrical conductivity of chromia-alumina dehydrogenation catalyst. P. B. WEISZ, C. D. PRATER AND K. D. RITTENHOUSE. Letter in *J. chem. Phys.*, **21**, 2236 (*Dec.*, 1953).

Simultaneous measurements were made of the conductivity κ and of the reaction rate for the dehydrogenation of cyclohexane at 480°C. The catalyst is a *p*-type (electron acceptor) semiconductor, as shown by the dependence of κ on the partial pressure of oxygen; immediately after contact with the reactant it changes to *n*-type. A tentative explanation is proposed in terms of Cr^{4+} and Cr^{2+}, in addition to the Cr^{3+}, sites. S. J. GREGG

537.311.33 : 541.128

4537. Electrical conductivity of hydrocarbon cracking catalyst. P. B. WEISZ, C. D. PRATER AND K. D. RITTENHOUSE. Letter in *J. chem. Phys.*, **21**, 2236–7 (*Dec.*, 1953).

See also preceding abstract. Silica-alumina cracking catalyst is found to be an impurity semiconductor of the *p*-type, possibly because the incorporation of tervalent aluminium into the tetrehedral silica lattice creates the electron acceptor levels. The experimental activation energy E for conductivity is in good agreement with E for ionizing the electron deficiency in this structure. S. J. GREGG

537.311.33 : 621.314.7

4538. The drift transistor. H. KRÖMER. Note in *Naturwissenschaften*, **40**, *No.* 22, 578–9 (1953) *In German.*

The drift transistor is a junction transistor with a concentration gradient of impurities in the central or base region. If ΔV is the p.d. due to the concentration gradient, and has a maximum value of $\sim 8kT$, it may be shown that (1) the limiting frequency may increase by as much as 8 times, (2) the gain factor $1 - \alpha$ may decrease by 8 times and (3) the collector output impedance will increase. C. A. HOGARTH

537.311.33 : 621.38 : 621.314.63

4539. The reduction of rectifier noise by illumination. J. W. GRANVILLE AND A. F. GIBSON. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 1118–19 (*Dec.*, 1953).

The experimental observations made on a Ge *n*-type rectifier are presented graphically and the results are shown to be in accord with recent ideas on noise in Ge [*Bell Syst. tech. J.*, **31**, 950–75 (*Sept.*, 1952); Abstr. 72 B (1953)] and observations of high current gain at low emitter current in Ge transistors [*Proc. Inst. Radio Engrs*, **40**, 448–54 (*April*, 1952); Abstr. 3107 B (1952)]. A reduction of 14 db was obtained. W. BARDSLEY (R)

537.311.35

4540. The electrical conductivity of molten oxides. A. E. VAN ARKEL, E. A. FLOOD AND N. F. H. BRIGHT. *Canad. J. Chem.*, **31**, 1009–19 (*Dec.*, 1953).

In order of decreasing equivalent conductances at their melting points the oxides investigated were: Li_2O, PbO, TeO_2, MoO_3, Bi_2O_3, V_2O_5, Sb_2O_3 and CrO_3. The variation of the observed values of the specific conductivities, K, with the absolute temperature, T, can be described by an equation of the form, $\log K = A + BT^{-1} + CT^{-2} \ldots$, where A, B, C, etc., are constants. While the experimental data are adequately described by an equation of this form containing only the constants A and B, a slightly better fit is obtained using three constants. The conductivities of the molten oxides follow a pattern of variation from element to element which is substantially the same as that of the molten halides. For elements giving more than one oxide stable in the molten state, the oxide corresponding to the highest state of valency has the lowest conductivity. A.

537.311.35

4541. Electrical conductivity of the perylene-bromine complex. H. AKAMATU, H. INOKUCHI AND Y. MATSUNAGA. Letter in *Nature* [*London*] **173**, 168–9 (*Jan.* 23, 1954).

The pure aromatic hydrocarbon perylene has a very high resistivity of the order of 10^{22} Ω.cm. By adding bromine to a benzene solution of perylene a complex is precipitated of composition one perylene molecule to three or four bromine atoms and this substance has a resistivity of only a few Ω.cm initially. A similar complex with bromine is formed by dibromoperylene and this also has a low resistivity. The complexes are not stable and their resistivities increase with time. The low resistivity is partly due to ionic conductance and partly to electronic conductance. J. IBALL

537.311.4

4542. The effect of compressive and shearing forces on the surface films present in metallic contacts. M. COCKS. *Proc. Phys. Soc.* [*London*] *B*, **67**, 238–48 (*March*, 1954).

Two electrical methods were used to examine the extent to which the oxide or other natural surface films can prevent intermetallic contact when metal bodies are pressed together. One consisted of measuring the electrical resistance of the contact, the other of measuring the thermoelectric force which arises when there is a temperature gradient across the film; crossed cylinders were used for the contact members. Precautions were taken to minimize vibration and shearing forces when applying normal loads. The contact resistance was often as large as several ohms, showing that penetration of the films was negligible, and in some cases the variation of resistance and thermoelectric force with load was consistent with the assumption that the contact contained a uniform film. Friction forces up to a certain critical value could generally be exerted in the normally loaded contacts before any metallic contact appeared, and in certain cases the films remained intact even during sliding. When the film was penetrated, the area of metallic contact was small at first, but grew as sliding proceeded; there was a simultaneous growth in the force resisting sliding. Microscopic examination showed that the metal surfaces suffered severe damage only after an appreciable distance of sliding (of the order of 0·1 mm). A.

537.312.5

4543. A new type of fatigue in photovoltaic cells. G. Blet. *C.R. Acad. Sci.* [*Paris*] **238,** 228–30 (*Jan.* 11, 1954) *In French.*

537.312.5 : 535.345

The electrical properties of cadmium sulphide films. *See Abstr.* 4387

537.312.5 : 535.345–15

Infrared photoconductivity of single crystals of tellurium. *See Abstr.* 4389

537.312.5 : 535.376

4544. X-ray-induced photostimulated conductivity in magnesium oxide. A. S. Eisenstein. *Phys. Rev.*, **93,** 1017–18 (*March* 1, 1954).

Single crystals of MgO luminesce under X-ray excitation with a multiband spectrum. The 3·6 eV band exhibits a long-time phosphorescence accompanied by an induced photoconductivity. Photostimulation of crystals previously X-ray-irradiated produced a sizeable photoconductivity during the excitation. This, together with the phosphorescence, decays with time. Remote hole trapping may account for these observations. A.

537.312.5 : 537.311.33

4545. Sensitization of the internal photoeffect of semiconductors by chlorophyll and allied pigments. E. K. Putseĭko and A. N. Terenin. *Dokl. Akad. Nauk SSSR*, **90,** *No.* 6, 1005–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-147.

The sensitivity of the sensitizing agents employed was found to be zero. Chlorophyll absorption on ZnO in powder form took place in air from diluted solutions in ethyl alcohol. The degree of pigmentation was small. Additional photoelectric bands appeared at 0·43 and 0·65 μ as well as the usual peak at 0·37 μ. Other materials such as magnesium phthalocyanin, iron porphyrin complex and haematin were studied as sensitizing agents. C. A. HOGARTH

537.312.5 : 537.311.33

4546. Influence of the adsorption of gases and vapours on the characteristic photoelectric effect of ZnO and on the photoelectric effect of ZnO sensitized by chlorophyll and similar pigments. E. K. Putseĭko. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 5, 1071–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-149.

The photo-e.m.f. of powdered samples was measured at room temperature under various conditions of ambient atmosphere. Reduction of oxygen pressure lowers the photo-e.m.f. but this is restored when the pressure is restored. Prolonged pumping out causes an irreversible decrease. The photo-e.m.f. is much increased if the ambient atmosphere contains a trace of quinone vapour. The decay of photoconductivity has two time constants of order 6×10^{-6} and 5×10^{-3} sec. The experiments on chlorophyll-sensitized layers suggest that the action of sensitization is for the pigment to absorb the light and the energy increase to excite an electron from an oxygen trap into the conduction band. An activation energy of 1·6 eV seems appropriate to this process.

C. A. HOGARTH

537.312.5 : 537.53

4547. Effect of X-rays on photovoltaic cells. G. Blet. *C.R. Acad. Sci.* [*Paris*] **238,** 72–3 (*Jan.* 4, 1954) *In French.*

Estimates of the effective quantum efficiencies for 40, 60 and 80 kV X-rays incident on Se cells. An explanation for the process involving secondary electrons and X-rays is offered. C. A. HOGARTH

537.312.5 : 537.58

4548. External photo-emission of thin films deposited by evaporation from barium oxide. S. Narita. *J. Phys. Soc. Japan*, **9,** 22–7 (*Jan.–Feb.*, 1954).

The properties of thin films, deposited on to clean metal surfaces by evaporation from a barium oxide cathode, were studied simultaneously by means of photoelectric and thermionic procedures. Both photoelectric and thermionic emission had close dependence upon the concentration of atomic barium in the barium oxide source cathode. As long as the deposited layer was very thin, the spectral distribution of photoemission fitted Fowler's plot well, but as the layer became thicker, semiconductor-type photoemission appeared gradually. The maximum sensitivity of photoemission from several molecular layers of BaO displaced 2·72 to 2·30 eV, together with the decrease in thermionic work function from 1·7 to 1·0 eV with increasing barium density of the layer. A.

537.312.5 : 548.7

4549. Influence of temperature and oxygen on the rise and decay of photoconductivity in single crystals of cadmium sulphide. B. Seraphin. *Ann. Phys.* [*Leipzig*] **13,** *No.* 1–5, 198–213 (1953) *In German.*

Measurements were made in 10 CdS crystals over a temperature range 20–350°c using rectangular pulses of light as excitation. The crystals were heated *in vacuo* and in 10 mm Hg oxygen pressure to 350°c which gave rise to very different lattice defect conditions in the two cases. The previous finding of a rise and decay process with mono- and bimolecular components was confirmed. The proportion of monomolecular behaviour depends markedly on temperature and defect concentration in contrast to the bimolecular process. Formal relations between the steady state photocurrent, the temperature, excitation intensity and oxygen treatment are derived.

G. F. J. GARLICK

537.312.5 : 621.383

4550. Photoelectric conductivity of lead sulphide. H. Frank. *Slaboproudý Obzor*, **14,** *No.* 6, 243–57 (1953) *In Czech.*

A brief survey of internal photoelectric phenomena is given and the photoelectric effect in PbS is explained in terms of the energy band model. The properties of natural galena are briefly discussed, the conclusion being that natural PbS is unsatisfactory for the manufacture of photoresistors. Artificially, PbS is prepared (*a*) by a direct synthesis of Pb and S; (*b*) by a chemical reaction of a solution of Pb acetate and H_2S. The photoelectric resistors are prepared either by depositing PbS on a glass base as a result of the chemical reaction between the solutions of Pb acetate, $CS(NH_2)_2$ and NaOH, or by the evaporation of pure PbS in vacuum on to a piece of glass. Three types of photoresistors are made (in Czechoslovakia) by the

...tter method; one of these is externally cooled by ...ry ice; the other two have sensitive surfaces of 1·5 ...nd 16 mm² respectively. Their properties are as ...llows: operating voltage 40 V; load resistance ...·1–2 MΩ, internal resistance of non-cooled photo...ells 1–10 MΩ; lowest detectable energy ~10^{-9} W, or ...ven less in the case of ice-cooled resistors; uniform ...pectral sensitivity down to 2·5 μ; efficiency of the ...on-cooled photocells is ~0·1 A/W, this figure being ...0 times higher for the cooled resistors; frequency ...esponse 10 kc/s; good stability after initial ageing. ...he properties of the PbS photocells are illustrated ...y a number of graphs and tables. The photo...esistors have been successfully employed for film ...ound reproduction; other applications such as ...nfrared telephony, are suggested. 54 refs.

R. S. SIDOROWICZ

537.312.6

4551. Measurements on the electrical resistivity of thin nickel films at very low temperatures. A. VAN ITTERBEEK, L. DE GREVE, L. VAN GERVEN AND K. SABBE. *Physica*, **20**, 1–6 (*Jan.*, 1954).

Deals with the electrical and magnetic properties of very thin nickel films at liquid-helium and liquid-hydrogen temperatures. It was found that the electrical resistance of such nickel films is a very sensitive function of temperature and measuring current, thus confirming measurements on iron films [Abstr. 4347 (1952)]. An external magnetic field did not change the current-dependence of the resistance. The existence of hysteresis was demonstrated by means of resistance measurements, and the coercive force determined. This was found to be much greater than for the bulk metal, and also than for iron films.

A.

537.312.62

4552. Properties of the superconducting modification of bismuth. N. V. ZAVARITSKIĬ. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 787–90 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-172.*

A new investigation of the superconducting properties of Bi films deposited at 4·2°K. The transition occurred at 6·0°K with sharpness of order 0·03°K for specimens thicker than 10^{-6} cm, but for thinner specimen T_c decreased gradually and became less sharp. Rise of temperature above a critical value T_0 destroyed the superconducting modification and T_0 varied from about 30°K for films 10^{-5} cm thick to about 11°K for 10^{-5} cm thick, where it became nearly independent of thickness. Some films were also deposited on a layer of the non-superconducting modification of Bi, rather than directly on glass, and these had lower values of T_0, but the same values of T_c. The H_c values as functions of T and thickness behaved similarly to those found for other superconductors, and are interpreted in terms of the Landau–Ginsburg theory. D. SHOENBERG

537.312.62

4553. Distribution law of supercurrents among parallel superconductors. G. PHILBERT. *C.R. Acad. Sci.* [*Paris*] **237**, 1148–51 (*Nov.* 9, 1953) *In French.*

The distribution law for n superconductors in parallel is formulated, and a special case considered.

D. SHOENBERG

537.312.62

4554. A definition and calculation of the coefficient of self-inductance of a superconductor. G. PHILBERT. *C.R. Acad. Sci.* [*Paris*] **237**, 1403–5 (*Nov.* 30, 1953) *In French.*

A generalized definition is suggested on the basis of the London's equations and worked out for a cylindrical wire. D. SHOENBERG

537.312.62

4555. The isotope effect in superconductivity. J. DE LAUNAY. *Phys. Rev.*, **93**, 661–5 (*Feb.* 15, 1954).

The isotope effect in superconductors is usually summarized by giving the observed values of p in the equation $M^pT_c =$ constant, where M is the isotopic mass and T_c the superconducting transition temperature. Fröhlich predicted the value $p = 1/2$, but the measurements in some instances show deviations from this prediction. An explanation of the deviation of p from 1/2 is offered based on an analogue of Wien's displacement law applicable to the vibration spectrum of real crystal lattices. The departure of p from the value 1/2 is attributed to the departure of the frequency spectrum from a simple power law. For many superconducting elements, p may be estimated from specific heat data, when such data are available to the desired degree of accuracy. A value of p is calculated for Sn which is in good agreement with some of the experiments. The large value 0·73 observed for Pb is shown to be reasonable. The values of p for the other superconducting elements are discussed. It is concluded that the observed deviations of p from 1/2 are not necessarily in conflict with the theories of Fröhlich and Bardeen. A.

537.312.62

4556. The superconductivity of some transition metal compounds. G. F. HARDY AND J. K. HULM. *Phys. Rev.*, **93**, 1004–16 (*March* 1, 1954).

About eighty transition metal compounds comprising borides, carbides, nitrides, oxides, silicides and germanides of metals of Groups 4A, 5A and 6A were tested for superconductivity down to 1·20°K, using a magnetic method. Among the specimens were most of the known compounds of the above type not examined magnetically for superconducting behaviour by previous workers, and in all cases the structures were checked by X-ray diffraction analysis. The following eleven new superconductors were discovered, with the transition temperatures (°K) shown in parentheses: W_2B (3·10°), Nb_2C (9·18°), Ta_2C (3·26°), Nb_4N_3 (7·2°), V_3Si (17·1°), V_3Ge (6·01°), Mo_3Si (1·30°), Mo_3Ge (1·43°), α-$ThSi_2$ (3·16°), β-$ThSi_2$ (2·41°) and W_3Si_2 (2·84°). These compounds include the first superconducting germanides, V_3Ge and Mo_3Ge, which, together with V_3Si and Mo_3Si, crystallize in the cubic β-tungsten structure. The transition temperature of V_3Si is apparently the highest known for any binary superconducting compound. A.

537.32 : 536.48

4557. Thermo-electricity at low temperatures. II. The alkali metal group. D. K. C. MACDONALD AND W. B. PEARSON. *Proc. Roy. Soc. A*, **221**, 534–40 (*Feb.* 9, 1954).

For Pt I, see Abstr. 7690 (1953). The thermo-electric behaviour of all the alkali metals has now been

measured in detail, together with some alloys, in the low-temperature region below ~80°K. At best, only sodium conforms approximately with the predictions of conventional electron-transport theory; lithium and caesium in particular show positive thermoelectric powers over the whole range measured, and rubidium is also positive at the lowest temperatures. A sharp inflexion is found in the thermo-e.m.f. of lithium at ~30°K. An empirical rule, useful in the discussion of dilute alloys, is proposed. A.

537.321.08 : 621.317.32.027.21 : 621.375.2.024

4558. A method for amplifying extremely small thermoelectric voltages. W. KROEBEL. *Z. angew. Phys.*, **5**, *No.* 8, 286–91 (1953) *In German.*

Describes an amplifier for signals of order $1{\cdot}5\times10^{-9}$ V at about 10 c/s and from a measuring circuit resistance of 10 Ω. With modifications 10^{-10} V can be measured. C. A. HOGARTH (R)

537.36 : 536.7

4559. Thermodynamics of electrokinetic phenomena. J. T. G. OVERBEEK. *J. Colloid Sci.*, **8**, 420–7 (*Aug.*, 1953).

The thermodynamics of irreversible processes are applied to electrokinetic experiments. By investigating the correlation between fluctuations in volume and charge in an electro-osmosis cell, the Onsager relation for this case is derived. From this and the empirical equation relating flow of liquid and electricity to pressure and potential difference, general relations between electrokinetic effects are derived, showing that for a given system the total electrokinetic behaviour is described only by one coefficient. From an application of the same method to the case of suspended particles, relations between electrophoresis and sedimentation are derived. Attention is drawn to electrokinetic corrections to be applied to the coefficients of permeation or of sedimentation in the form in which they are usually determined. A.

ELECTRIC DISCHARGES 537.52

537.52 : 533.7

4560. The mathematical theory of electrical discharges in gases. B. Velocity-distribution of positive ions in a static field. T. KIHARA. *Rev. mod. Phys.*, **25**, 844–52 (*Oct.*, 1953).

A revised version of parts of a book in Japanese by the same author, *Imperfect Gases* (1949), to which reference was made in an earlier article of the same title [Abstr. 4368 (1952)]. Discusses heavy ions in a light gas, the Maxwellian model of collision cross-sections, the general theory of mobility and mobility in weak electric fields. See also Abstr. 7044 (1951).

E. H. SONDHEIMER

537.52 : 537.363

4561. The analysis and purification of rare gases by means of electric discharges. R. RIESZ AND G. H. DIEKE. *J. appl. Phys.*, **25**, 196–201 (*Feb.*, 1954).

Through the phenomenon of cataphoresis in gas discharges, impurities are carried toward the cathode and concentrated there. This can be used for the purification of rare gases, in particular, for th removal of traces of one rare gas from another ra gas. The technique is simple and completely aut matic. The same technique can be used for th analysis of rare gases. The high concentration of t impurities near the cathode increases the sensitivi by a large factor. One part of neon in 200 millio parts of helium has been detected without difficultie

537.523.5 : 621.315.5.066.6 : 621.316.5.064

4562. Arcing at electrical contacts on closur IV. Activation of contacts by organic vapor. L. B GERMER. *J. appl. Phys.*, **25**, 332–5 (*March*, 1954).

For Pt III, see Abstr. 5799 (1952). The activatio of electrical contacts by decomposition products fro organic vapours depends upon an adequate surfa layer of adsorbed molecules. In earlier work mi mum vapour pressures were given for activation b a number of organic compounds. From new exper ments reported here the time available for adsorptio between successive arcs is equally important, so th the minimum vapour pressure for activation to occ is inversely proportional to the time available fo adsorption, or directly proportional to the rate o operation. The effective contact area and the energ are important also and, although quantitative da have not been obtained, it is reasonable to guess tha these variables are connected by a relation not fa from $p/n = KE/A$, where n is the minimum rate fo activation to occur for the pressure p on the effectiv contact area A with the available energy E. Quantita tive experiments have been made only upon th activation of palladium contacts by vapour or th organic compound known as fluorene, and only th proportionality between p and n has been establishe

537.52

4563. A contribution to the quantitative course of th discharge production. E. PFENDER. *Z. angew. Phys* **5**, *No.* 12, 450–3 (1953) *In German.*

Describes measurements of voltage-current charac teristics of discharges from just below the sparkin voltage through the glow discharge to the arc. Thre types of tube were used, (1) Hg cathode and Ni anod 2·5 cm apart; (2) Hg cathode and graphite anod 3·5 cm apart; (3) tungsten electrodes 1·5 cm apart The gas fillings were A at 0·1 mm Hg, A at 4 mm H and Ne at 40 mm Hg respectively. Tube (1) gave th most reproducible results. J. DUTTON

537.52

4564. The role of light quanta in the electric breakdown of gases. W. L. HARRIES AND A. VON ENGEL *Proc. Roy. Soc. A*, **222**, 490–508 (*March* 23, 1954).

The idea that multiplication of electrons by direc collisions with gas atoms can account for the startin of discharges has been found to be untenable in neo over a wide range of pressure and wavelengths. Also the dictum that wall processes can be neglected whe the gas pressure is high appears to be a fallacy. The experiments leading to these conclusions were don with cylindrical glass vessels with plane ends and external electrodes and uniform alternating electri fields. With pressures from 2 to 200 mm Hg, as the wavelength was varied between 10 and 10^7 m, the

rting field showed three plateaux, the lowest at ort wavelengths. Here for $p > 50$ mm Hg the field r unit pressure was found to be constant and very w, namely, 0·6 V/cm mm Hg. Using even the most vourable energy distribution, the fraction of elec- ons exceeding ionization energy of about 21 eV is uch too small to give electron mutiplication by llision which can balance the losses by diffusion. owever, there is a much larger fraction of electrons hich can excite neon atoms to resonance or metast- le levels. Thus a new picture emerges; a chance ectron which is accelerated by the field excites eon atoms to about 16 eV. The emitted quanta hich fall on the glass walls release photoelectrons hich join the first electron, etc.; hence, not only re electrons multiplied but also quanta. When ne concentration of excited atoms has become ufficiently great, the large number of slow electrons ith energies >5 eV can ionize the excited gas. Thus ne starting field corresponds not to ionization by ollision but to the onset of multiplication of quanta nd photo-electrons during the first stage of the reakdown. The theory given leads to a relation etween the starting field and its wavelength, the gas ressure, the size of the vessel, the nature of the gas nd of the wall. Good numerical agreement with bservations is found, the constants being taken from nown atomic data. The concept of the electron multiplication sustained by quanta may have a bearing on other types of discharge in different gases. A.

537.525.3

4565. Fast time analysis of intermittent point-to-plane corona in air. I. The positive point burst pulse corona. M. R. AMIN. *J. appl. Phys.*, **25**, 210–16 (*Feb.*, 1954).

Techniques for fast oscilloscopic analysis of intermittent point-to-plane coronas in air are described. Such analysis shows the positive point burst pulse corona to consist of an initial pulse followed by secondary pulses at varying time intervals. The duration of both pulses is less than 10^{-7} sec, the initial pulses having from 1 to 2×10^7 ions and the secondaries from 1 to 5×10^6 ions depending on the voltage. Time intervals between pulses range from the clearing time of ions across the gap (milliseconds) to random intervals as short as 2 μsec for secondary pulses well above threshold. Thus, in analogy to Geiger Counter terminology dead times run from 2 μsec up, and clearing times are in the order of msec corresponding to local clearing of space charge near the point for secondaries, and removal of massive space charge from the low field region of the gap. A complete sequence of events from threshold to steady corona is analysed, and indicates the predominance of self-counting through negative ion formation in air. A.

537.525.8

4566. Structure and mechanism of the negative [Lichtenberg] figure of a discharge. W. WEIZEL AND C. MEYER. *Z. Phys.*, **136**, *No.* 3, 262–84 (1953) *In German.*

The characteristic details of Lichtenberg figures produced at negative point electrodes under potentials ~ 35 kV at pressures of the order of a few hundred mm Hg are illustrated and explained in terms of the development of the local electric field. C. G. MORGAN

537.527.5

4567. An investigation of an arc-discharge in nitrogen at increased pressure. P. J. SOMERS. *Utrecht: The University* (1954) x + 80 *pp. In Dutch. Summary* (1 *p.*) *in English.*

This comprehensive thesis includes sections on (I) a survey of the relevant literature and (II) a description of the arc chamber and exptl. methods (optical and electrical). The apparatus may be used at pressures varying up to 15 atmos. Carbon and carbon-salt filled electrodes were used. Section (III) discusses the measurement of excitation temps. by observation of intensity variations in CN and C_2 bands. The author suggests that the previous published transition probabilities of various bands (e.g. the 4216 Å CN band) should be corrected. Section (IV) discusses these corrections. Section (V) deals with problems related to the macroscopic discharge, e.g. self-absorption in certain bands, particularly at the higher pressures. Finally (VI) there is some discussion of line broadening processes, especially in relation to temperature measurements (e.g. by Doppler widths). There are 48 references.

J. D. CRAGGS

537.528

4568. On the electric strengths of aliphatic hydrocarbons. R. W. CROWE, J. K. BRAGG AND A. H. SHARBAUGH. *J. appl. Phys.*, **25**, 392–4 (*March*, 1954).

Paschen's similarity law, which expresses a certain relationship between the breakdown voltage of a gas, the gas pressure and the distance between electrodes, is known to fail at high pressures. This is owing, at least in part, to a change in the way in which electrons dissipate energy to the gas molecules. At high enough pressure, the electron transfers energy principally to molecular vibrations. In condensed phases this vibrational barrier is dominant, and one should expect a new kind of similarity law to hold under certain controlled conditions. The liquid aliphatic hydrocarbons provide an illustration of such a law. The electric strengths of nine hydrocarbons of various densities were measured, and found to depend linearly upon density. It has also been found that the temperature dependence of the electric strength of a liquid aliphatic hydrocarbon can be accounted for by the change in density of the liquid due to thermal expansion. A.

537.528 : 621.3.015.5 : 621.315.615

4569. Cathode effects in the dielectric breakdown of liquids. J. K. BRAGG, A. H. SHARBAUGH AND R. W. CROWE. *J. appl. Phys.*, **25**, 382–91 (*March*, 1954).

The apparent (measured) electric strength of a liquid dielectric depends on the nature of the cathode used. The field emission of electrons from the metallic cathode is assumed to be responsible for this effect; it may provide space charge which distorts the electric field in the dielectric. The nature of the cathode determines the range of electric fields over which the emission becomes appreciable. The emission of charge and the formation of space charge are discussed in detail. Because of theoretical and experimental uncertainties connected with supposedly uniform metallic surfaces, an electrode consisting of an electrolyte solution is also considered. Although the

experimental results demonstrate that ions are emitted from such cathodes under the influence of strong electric fields, the role in providing space charge is similar to that of metal electrodes which emit electrons. For the former electrode, the considerations regarding space charge formation predict a definite dependence of apparent electric strength on electrolyte concentration and provide a way of testing the basis of the theory. Certain experiments reported here confirm the predictions of the theory. A.

537.529

4570. Dielectric breakdown of thin alumina film. H. KAWAMURA AND K. AZUMA. Note in *J. Phys. Soc. Japan*, **8**, 797–8 (*Nov.–Dec.*, 1953).

Measurements of dielectric breakdown in thin films of various thicknesses give values of mobility and relaxation time of the conduction electrons. Measurements at various temperatures agree with, Debye temp. = 300°K. W. M. LOMER

537.529 : 537.312 : 542.92 : 621.315.616.9

4571. Thermal decomposition of organic insulating materials in relation to the mechanism of tracking. V. E. YARSLEY, W. J. GRANT AND G. C. IVES. *Rep. Brit. Elect. Res. Assoc., Ref. L/T274*, 13 *pp.* (1952).

To supplement the empirical information available, thermal decomposition of a number of relevant materials was studied. The bearing of the results on tracking phenomena is indicated. A.

X-RAYS 537.531

537.531

4572. "Lattice-source" interference [phenomena] of hard X-ray bremsstrahlung. H. C. WOLF. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 381–403 (1953) *In German.*

By "lattice-source" interference is meant the type of interference investigated by Kossel in which the source of the X-rays lies within a crystal, in the present instance a metal single crystal. Electrons of up to 400 kV impinge on a spherical metal crystal which acts as a source of X-rays and also as a "monochromatizing" filter. Thin crystal plates, with additional filtration are also used. Effects are observed photographically which are likened to Kikuchi bands obtained by X-rays, and are studied in the light of the dynamic theory of diffraction. J. THEWLIS

537.531

4573. The albedo of various materials for 1-MeV photons. E. HAYWARD AND J. HUBBELL. *Phys. Rev.*, **93**, 953–6 (*March* 1, 1954).

The Monte Carlo method has been used to determine the albedo of 1 MeV photons reflected from semi-infinite slabs of water, aluminium, copper, tin and lead at various angles of incidence. The case histories of 67 photons were followed. For normal incidence the number of albedo varies from 33% for water to 0·5% for lead, and the energy albedo from 5% for water to 0·1% for lead. A.

537.531 : 535.33.07

4574. The synthesis of X-ray spectrometer line profiles with application to crystallite-size measurements. L. ALEXANDER. *J. appl. Phys.*, **25**, 155 (*Feb.*, 1954).

An improved convolutional method is used to synthesize theoretical line profiles generated by joint action of seven instrumental weight functi characteristic of the X-ray spectrometer. Th include in addition to the five geometrical fact described in a previous publication: (VI) a so-cal misalignment function and (VII) a spectral impu function. The method is applied to the new spect meter design incorporating a narrow X-ray sou Soller slits and an angular range $2\theta = 0$ to 165° higher. Good agreement between theoretical a experimental line profiles is achieved for qua reflections at $2\theta = 24{\cdot}0$ and 90·7°. The impro treatment is used to define new curves for correcti experimental spectrometer line breadths for inst mental broadening effects. It is demonstrated th spectrometers of the new design are capable measuring crystallite dimensions as large as 3000 Å.

537.531 : 535.33.07 : 621.387.46 : 621.317.7

4575. An X-ray spectrometer for the 200 kV regi using a scintillation counter. W. J. H. BEEKMA *Trans Instrum. Meas. Conf.*, **1952**, 84–7.

In an investigation of the radiation from a gri controlled pulsed X-ray tube the peak kilovoltage w measured by applying the Duane–Hunt law to t minimum wavelength generated. The spectromet uses a quartz reflecting crystal and as detector scintillation counter of Tl-activated NaI. An integr tion circuit gives a meter reading proportional photon energy at a given wavelength; absolu measurements of energy distribution are not easy b relative values allow the effects of generator wavefor and the minimum wavelength emitted to be assesse with an accuracy of 5%. L. E. MUSSEL

537.531 : 535.34

4576. X-ray absorption spectra of Ni, Cu and Z ions in aqueous and non-aqueous solutions. É. I VAĬNSHTEĬN AND V. S. KAVETSKIĬ. *Dokl. Akad Nauk SSSR*, **91**, *No.* 4, 775–8 (1953) *In Russian* English translation, *U.S. National Sci. Found NSF-tr-141.*

The fine structure of the X-ray absorption edge i found to be characteristic of the solvated ion Changes depend mainly on the dipole moments of th various solvents, anions in solution not interferin appreciably with line positions, although intensities i the Zn edge were different for dissolved $ZnCl_2$ an $Zn(NO_3)_2$, probably because of varying degrees o dissociation. A. L. MACKA

537.531 : 535.345 : 66

4577. The X-ray absorption coefficients for a borosilicate glass. S. L. WHITCHER AND N. TODD *Radiology*, **61**, 103–5 (*July*, 1953).

537.531 : 537.312.5

4578. X-ray noise observation using a photoconductive pickup tube. A. D. COPE AND A. ROSE. *J. appl. Phys.*, **25**, 240–2 (*Feb.*, 1954).

A television pickup tube arrangement using a Vidicon for the direct recording of X-ray images is described. The transmitted X-ray picture shows noise characteristics that are clearly those of the

sorbed X-ray photons. The internal conversion n (number of carriers generated per absorbed ray photon) is estimated by two independent thods, one of which is based on a measurement of ray noise. Both methods give a gain of about 500 100 kV X-ray photon. The agreement between two methods is evidence for the validity of the aple electron-multiplier model for the noise current the photoconductive selenium target. The pearance of X-ray noise means that all the informa- n contained in the absorbed fraction of the X-ray am is being transmitted. Thirty pictures per cond are transmitted when irradiating the Vidicon th a 5 mA, 100 kV X-ray beam at a distance of o feet. Wires of one mil diameter were clearly bservable. A.

537.531 : 537.533.7

579. **On the fundamental law of the physical action f X-rays of different wavelengths. II.** R. GLOCKER. *. Phys.*, **136**, *No.* 3, 352–66 (1953) *In German.*

For Pt I, see *Z. Phys.*, **46**, *No.* 9–10, 764 (1928). the range of the secondary electrons is considerable, ie energy balance equation in any volume V is made p of three terms: (*a*) electron energy produced in olume V; (*b*) fraction of this energy leaving V; c) energy flux due to electrons produced outside and ntering V. These three terms are calculated under implifying assumptions; results are in agreement with ata on the wavelength dependence of the response of onization chambers and counters with walls of dif- erent materials. L. PINCHERLE

537.531 : 545.824

Experimental arrangement for X-ray absorption nalysis. *See Abstr.* 5101

537.531.08

1580. The concept of dosage and the roentgen unit. R. GLOCKER. *Z. Phys.*, **136**, *No.* 3, 352–66 (1953) *In German.*

The validity of the roentgen as a measure of X-ray losage in media other than air, is discussed from a mathematical treatment of the energy given up by the secondary electrons. The limits of application of the Bragg–Gray theory are considered, and it is concluded that, for high-energy X-rays which release electrons whose relative stopping power for air-solid media is not independent of their energy, prediction of dosage from air ionization measurements is no longer possible. D. V. MABBS

537.531.08

4581. Oscillography of intensity variations of X-radiation. W. HÜBNER. *Z. angew. Phys.*, **5**, 461–2 (*Dec.*, 1953) *In German.*

X-rays fall on a light-sealed NaI crystal whose luminescence (proportional to the X-ray intensity received) operates a photomultiplier tube, total current from which is developed across a resistance and applied to a cathode-ray oscillograph. Variation of X-ray intensity with applied waveform can thus be observed. Typical oscillograms are shown and discussed. D. V. MABBS

537.531.08 : 536.6

4582. Calorimetric evaluation of the roentgen for 440 kV and 22·5 MeV roentgen rays. J. S. LAUGHLIN, J. W. BEATTIE, W. J. HENDERSON AND R. A. HARVEY. *Amer. J. Roentgenol.*, **70**, 294–312 (*Aug.*, 1953).

The significance of the difference between intensity and dose is emphasized. The high-sensitivity calorimeter, described in detail, uses "thermistors" as elements, with a bridge measuring circuit. Combination of flux measurements and ionization distribution has been applied to obtain energy dose (ergs/g) as a function of depth in an irradiated body. It is suggested that this calorimeter could be used for the calibration of total output flux of X-ray generators, and especially those above 1 MeV. D. V. MABBS

CATHODE RAYS POSITIVE RAYS 537.533/.534

537.533 : 615.849.1 : 621.384.62

4583. An 8-MeV linear accelerator for X-ray therapy. C. W. MILLER. *Instn Elect. Engrs Paper* 1619, 13 *pp.* [To be published also in *Proc. Instn Elect. Engrs*].

A general account of a 4-year research and development programme which has resulted in the installation at Hammersmith Hospital of a new type of supervoltage therapy equipment. This machine produces 8 MV X-rays, and stabilized outputs of up to 200 r/min at 1 m are available after filtration. Acceleration of the electrons is obtained by a 3 m length of corrugated waveguide energized by a magnetron giving a pulsed output of approximately 2 MW peak power at a free-space wavelength of 10 cm. Since the accelerating unit is fixed with its axis horizontal, the electron beam is deflected through a right angle before reaching the target, and the deflector system is made rotatable, to give variable direction of the X-ray beam. Many chemical facilities are available, and, in addition, the electron beam may easily be extracted. The background to the programme, the underlying principles and the basic design are dealt with followed by a description of the equipment and some details of its construction The investigation of the performance is covered in some detail, and certain improvements in the understanding of the properties of the accelerating waveguide are discussed. Finally, a comparison is made between measured and calculated performance and the agreement is shown to be satisfactory. A.

537.533 : 621.314.2 : 621.384.62

4584. The resonant transformer: A source of high energy electrons. J. A. KNOLTON, G. R. MAHN AND J. W. RANFTL. *Nucleonics*, **11**, 64–6 (*Nov.*, 1953).

The electron accelerator described employs a coreless transformer, with the secondary tuned to resonance, to provide the accelerating voltage. A permanently evacuated cathode-ray tube, passing down the axis of the transformer, has a window of stainless steel sheet over a steel grid support, through which the electron beam emerges. The available units give 500 μA beams with a peak energy of 1 MeV The beams are used for radiation sterilization, a dose rate of $3{\cdot}5 \times 10^7$ r/min being available at 4 in. from the window. L. R. SHEPHERD

537.533 : 518.5 : 621.384.62 : 621.317.79

Computer for problems in connexion with linear particle accelerators. *See Abstr.* 4091

537.533.2

4585. The work function of irregular metal surfaces. T. J. LEWIS. *Proc. Phys. Soc.* [*London*] *B*, **67**, 187–200 (*March*, 1954).

It is shown that the image potential of an electron outside an irregular metal surface is different from that for an ideal plane surface. Calculations of this potential for spherical and prolate spheroidal bosses on an otherwise smooth surface show that the image potential might easily be reduced by 50%. Since the image potential energy is likely to form a large portion of the work function for most metals, then the latter also will be significantly reduced when the surface is rough. The importance of this in the theory of electron emission from metals in practice is briefly discussed. A.

537.533.3

4586. The graphical construction of electron paths in potential fields. G. B. HAGEN. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 257–84 (1953) *In German.*

The two main methods of straightforward plotting of electron trajectories in electrostatic fields are analysed and their accuracy compared: the use of Snell's law at successive equipotential surfaces, and the fitting of the arcs of paths as calculated between successive equipotentials. Comparison was made of the results of each method with the exact solution, for simple systems of equipotentials in which successive surfaces were at varying angles from 0° up to 20°. Tables give the calculated paths in detail. It is shown that the Snell's law procedure is always more accurate than the arc-fitting method. The degree of error is investigated for different entry and exit velocity of the electron and for varying angles of incidence, as well as for various angles of inclination of the successive equipotentials. V. E. COSSLETT

537.533.3

4587. Limits to aberration coefficients in electron optics. O. I. SEMAN. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 3, 443–5 (1953) *In Russian.*

The coefficients are those of the primary aberrations of axially symmetric, static fields free from space charge. The limits are imposed by the condition that the fields are Laplacian and are obtained by consideration of the reduced eikonal [see *Abstr.* 8242 (1952)]. In addition to the well-known limitations, such as that on spherical aberration, limits have been found for the astigmatism and for the Petzval curvature. Numerical values are given, for electric and magnetic fields, of the constants which, together with values at object and image of the electric potential and field and of the height and slope of a paraxial ray, determine the lower limit of the curvature of the appropriate image surface. J. C. E. JENNINGS

537.533.3

4588. The geometrical optical intensity distribution in the focal spot of the deflected electron ray pencil. H. GRÜMM. *Optik*, **11**, *No.* 1, 32–43 (1954) *In German.*

Expressions are given for the intensity distribution near a focal spot when an electron beam is deflected by electrostatic or magnetic fields. Cases are considered in which the total aberration is made up of the sum and difference respectively of particular aberration terms. The former leads to a channel-shaped caustic surface; the latter to a caustic triangular cross-section.

A. E I. RESEARCH LABORATO

537.533.3 : 537.5

4589. On the optical properties of electron and beams with circular axes. H. GRÜMM. *Acta ph Austriaca*, **8**, *No.* 2, 119–40 (1953) *In German.*

The author investigates the electron-optical pr perties of beams whose central trajectory is a ci which lies in a plane normal to the axis of symme of electric and magnetic fields of rotational symme The paraxial properties and aberrations are deri from the Fermat principle and relevant mixed char teristic function (eikonal). The first-order con butions to the velocity and mass dispersions a calculated and so are the second-order aberratio the resultant intensity distribution in image-space investigated. The author also establishes formu for the third-order aberrations, which involves second-order perturbation calculation, and for t second-order dispersion. [The latter formulae a obtained by second-order methods whereas t problem must be considered as one involving third-order perturbation, as is shown in Abstr. 27 (1952)]. P. A. STURROC

537.533.3 : 533.6.011

The imaging of gas streams by electron beams. *S Abstr.* 4256

537.533.3 : 539.2

Electron diffraction apparatus with new electro optical system. *See Abstr.* 5034

537.533.331 : 621.385.83

4590. Theory of the triode-type electron gun wit cylindrical symmetry. E. LABLIN. *Onde élect.*, 3 597–605 (*Nov.*); 713–19 (*Dec.*, 1953) *In French.*

A method is described for calculating certai properties of the triode electron gun of cylindrica symmetry. The method is only strictly applicable i the absence of space charge, but it is claimed that th results obtainable are adequate even in the presence o space charge. A conformal transformation is made after certain simplifying modifications, to a system i which the electrodes are represented by segments of a continuous straight line. From the transformed field the cut-off potential and the extent of the emitting area of the cathode as a function of bias are obtained A further step gives the axial potential distribution.

M. E. HAINE (R

537.533.335 : 621.385.833

4591. On the focusing of high-current electron beams. G. R. BREWER. *J. appl. Phys.*, **25**, 243–51 (*Feb.*, 1954).

The focusing of high-current electron beams by means of a system of periodically spaced magnetic lenses has been studied. The trajectories of the electrons under the influence of magnetic and space-charge forces have been obtained by the use of an analogue computer. Graphs have been prepared which permit the design of a lens focusing system for given values of current, voltage and beam diameter. The solutions are obtained for the Glaser magnetic lens with longitudinal field variation of the form $B_z = B_0[1 + (z/a)^2]^{-1}$. The conditions of operation appropriate to

minimum chromatic aberration are obtained, and entrance conditions to the lens system discussed. A.

537.533.35

2. On the question of making visible single molecules in the field electron microscope. R. HAEFER. *a phys. Austriaca*, **8**, *No.* 2, 105–18 (1953) *In man.*

Evaporation of a series of organic substances from cathode of the field electron microscope produces pearances very similar to those found by Müller copper phthalocyanin and attributed by him to effect of single molecules, on the basis of a correndence between the four-fold symmetry of the age and that of the molecule. In the present work re is no such correspondence in symmetry and it concluded that the effects do not arise from the sence of single molecules. Various possible planations are considered including the formation crystallites from the organic molecules. J. THEWLIS

537.533.35

93. Variable field beta-ray spectrometer-spectrograph. R. KATZ AND M. R. LEE. *Rev. sci. Instrum.*, , 58–62 (*Jan.*, 1954).

The design and performance of a high-source type, 0° focusing, variable-field, β-ray spectrometer-ectrograph are described. Some details regarding e measurement of magnetic field, the construction end-window Geiger counters and the preparation d thickness measurement of thin Formvar counter ndows are also discussed. A.

537.533.35

94. Higher order focusing pair spectrometers. KITAGAKI. *J. Phys. Soc. Japan*, **9**, 4–5 (*Jan.–Feb.*, 54).

For the field of a pair spectrometer two butterfly-aped fields of higher character are shown. One is r low-energy use and higher-order focusing is hieved for all radii of trajectories. The boundary the magnetic field is a line through the origin and angle is 35° 16′; the focal plane is also a line rough the origin. The other is for the use of high ergy. When the boundary is a 45° line, the undary is the focal plane itself, and wide position-cusing is given at a point, which is determined by e curvature of the converter. A

537.533.7 : 621.385.032.2

95. Some effects of slow electron bombardment in ermionic valves. D. A. WRIGHT. *Brit. J. appl. ys.*, **5**, 108–11 (*March*, 1954).

Discusses first the general features of the interaction tween slow electrons and solids upon which they pinge. The threshold electron energies for the sorption of electrons, for the appearance of condary emission and for decomposing the bom-rded solid were measured for a number of com-unds. The values are quoted and are related to e optical absorption bands of the compounds. he effects on valve characteristics and on cathode nission are described briefly, when such compounds e present on the valve electrode surfaces. A.

537.533.72 : 621.385.833

96. The freely moving electron in electric and agnetic fields. A. SPORK. *Österr. Z. Telegr.-Teleph.-Funk-Fernsehtech* [*ÖTF*] **7**, 85–98 (*July–Aug.*, 1953) *In German.*

The trajectories of electrons in different types of electrostatic and magnetic fields are discussed mathematically, with special reference to television systems. The general solution of the equations of motion is first obtained and then applied to a variety of conditions: the electrostatic or magnetic field alone, both fields crossed normally or at an arbitrary angle and both fields in the same direction. In each case differing initial directions of electron injection with respect to the field vectors are discussed. There appears to be nothing new in the treatment or in the results, but it is valuable to have all the possible types of trajectory collected together and logically related. V. E. COSSLETT

537.533.73 : 548.74

4597. Distant interference of electron waves. O. RANG. *Z. Phys.*, **136**, *No.* 4, 465–79 (1953) *In German.*

Describes a detailed investigation of the complex interference patterns which are obtained when an electron beam is transmitted through two thin films of the same crystalline material which are separated by a small gap. The phenomena have already been briefly reported [Abstr. 5222 (1953)]. To distinguish these effects from the normal type of electron diffraction pattern produced from a continuous crystal lattice, the name "distant interference" (Fern-Interferenz) is proposed. The particular instance studied is that of the patterns from blisters in mica flakes, as made visible in the electron microscope in both bright and dark field operation. The changes in appearance with varying direction of illumination was investigated and explained in terms of a simple model of the blisters. The thickness of the gap at the centre of a blister could be calculated from the dimensions of the pattern, the value being 462 Å for one pattern. An appendix gives the method used to deduce the crystal axis from a normal single crystal electron diffraction pattern; knowledge of the direction of the axis is needed in interpreting the interference patterns. V. E. COSSLETT

537.533.74

4598. Polarization of electrons by scattering. IV. N. RYU. Note in *J. Phys. Soc. Japan*, **8**, 804–5 (*Nov.–Dec.*, 1953).

For Pt III, see Abstr. 524 (1954). Repeated double-scattering experiments with Au foils confirm polarization of only $\sim \frac{1}{2}$ the theoretical values [see Abstr. 7325 (1952)]. W. J. SWIATECKI

537.533.74

4599. Multiple scattering of fast electrons. O. KNECHT AND W. BOTHE. *Z. Naturforsch.*, **8a**, 805–14 (*Dec.*, 1953) *In German.*

Homogeneous beams of electrons from the β-decay of RaE in the energy range 250–1000 keV are scattered from metal foils (Al, Ni, Ag, Au) of various thicknesses. The multiple scattering is measured as a function of foil thickness and energy. The experiments agree with the theory of Molière [Abstr. 609 (1949)] in the region of validity of the assumptions of this theory; i.e., for not too thick foils. Various other theories are compared and criticized. Empirical corrections for thick foils are given. Experimental

results for oblique scattering are presented and compared briefly with the theory. G. E. BROWN

537.533.74

4600. The scattering of slow electrons by the diatomic molecules. II. Elastic scattering by the hydrogen molecules. S. NAGAHARA. *J. Phys. Soc. Japan*, **9**, 52–5 (*Jan.–Feb.*, 1954).

The author has applied the general theory developed in the preceding paper [Abstr. 4139 (1953)] to the elastic scattering of slow electrons by the hydrogen molecule, using the more exact molecular potential than those used in J. B. Fisk's paper. The calculation has been made for the following energies of the incident electron: 27·2 eV, 17·1 eV, 6·8 eV and 1·7 eV: the corresponding total cross-sections being 9·163, 19·43, 43·84 and 33·23 atomic units. The remaining discrepancy with the observed values may be attributable to the effect of exchange and of inelastic collisions. A.

537.533.74

4601. Higher-order potential effects in the radiative correction to scattering of slow electrons. M. H. MITTLEMAN. *Phys. Rev.*, **93**, 453–4 (*Feb.* 1, 1954).

The radiative correction to the scattering of low-energy electrons by an external field has been calculated in first Born approximation in the external field. For strong fields or slow electrons this is not a valid approximation. With the assumption that only low-energy virtual photons contribute significantly to the effect, the radiative correction to the scattering of slow electrons is calculated to all orders of the external field. There is no change in the fractional radiative correction from the Born approximation result. A.

537.533.74

4602. Elastic scattering of electrons by the Coulomb field of nuclei using Born approximations. VACHASPATI. *Phys. Rev.*, **93**, 502–13 (*Feb.* 1, 1954).

Calculations including the second Born cross-section for the elastic scattering of electrons by nuclei are performed taking a model for which the matrix elements are particularly simple. The potential corresponding to this model is a mixture of an attractive Coulomb and a repulsive Yukawa potential of range $1/B$ and relative strength C. The density is given by $\rho = -(C-1)\delta^3(\mathbf{r}) + (CB^2/4\pi)(e^{-Br}/r)$. Since the scattering is fairly insensitive to the details of the nuclear model, one can use the calculations made here to find scattering cross-sections on different models by suitably choosing B and C. This is done here for the uniform density model and the results are compared with the phase-shift calculations of Acheson for 15 to 35 MeV electrons. A fairly close agreement with his results is obtained up to medium elements ($Z \lesssim 50$). A.

537.533.74

4603. Nonsingle scattering of electrons at oblique incidence. M. HAMERMESH AND J. MONAHAN. *Phys. Rev.*, **93**, 963–4 (*March* 1, 1954).

A detailed calculation shows that effects of plural scattering of electrons are adequately described by the method of Goertzel and Cox. A.

537.533.79 : 539.166.835

4604. Theory of bremsstrahlung and pair production. I. Differential cross section. H. A. BETHE AND L. MAXIMON. *Phys. Rev.*, **93**, 768–84 (*Feb.* 15, 1954).

The differential cross-sections for bremsstrahlung and pair production are calculated without the use of the Born approximation, assuming the energy of the electron to be large compared to mc^2 both in initial and final state. The wave functions in initial and final state are essentially those previously proposed by Furry. It is proved that the wavefunctions agree with the exact ones of Darwin except for terms of relative order a^2/l^2, where $a = Ze^2/\hbar c$ and l is angular momentum, and that this agreement holds for any energy of the electron. An independent proof is given, showing that the Furry wave functions give the matrix element correctly except for terms of relative order $1/\varepsilon$. In the matrix element for bremsstrahlung the initial state of the electron must be represented by a plane wave plus an outgoing spherical wave, whereas the final state has an ingoing spherical wave. In pair production, both electrons contain ingoing spherical waves. This causes essential differences between the cross-sections for the two processes. The cross-section for pair production is calculated; the result consists of the Bethe–Heitler formula multiplied by a relatively simple factor, plus another term of similar structure. A simplified derivation is given, which is valid for the important case of small angles between electrons and quantum; it provides a useful check on the first calculation. The bremsstrahlung cross-section is calculated and found to be the Bethe–Heitler result multiplied by a factor. This factor is different from that encountered in pair production and becomes important only for very small momentum transfer q. In the limit of complete screening, the small q do not contribute and the cross-section goes over into that of the Born approximation. The error in the cross-sections calculated in this paper is estimated to be of order $1/\varepsilon$, where ε is the energy of the final electron in bremsstrahlung, or that of the less energetic electron in pair production, in units of mc^2. The total cross-section for pair production by a quantum of energy k may be in error by $\log k/k$.

537.533

4605. The mechanism of secondary electron emission. A. O. BARUT. *Phys. Rev.*, **93**, 981–4 (*March* 1954).

It is shown that a simple theory based on the constant energy loss per unit path length of primary electrons accounts quantitatively for the variation of secondary electron emission yield below its maximum value. The theory can be extended formally to include a Bethe-type energy loss at high primary energies. An attempt was made to clarify the present situation concerning the relationship between the secondary electron emission and the atomic structure of the elements, and some new relations are indicated. The mechanism of the secondary emission of insulators and semiconductors is also discussed.

537.533.8 : 535.3

4606. The effect of organic vapor on the secondary emission of phosphors. P. H. DOWLING AND J. SEWELL. *J. appl. Phys.*, **25**, 228–30 (*Feb.*, 1954).

Experiments are described to show that, when a phosphor surface contaminated with organic vapour is bombarded with electrons, the secondary emission

io is rapidly reduced. If the bombarding voltage is ficiently high, this will result in a progressive crease in potential of the phosphor surface and a rresponding decrease in apparent fluorescent iciency. The relation between this effect and true hosphor burn" is discussed as well as its possible nnection with the phenomenon of "cross burn" countered in the cathode-ray industry. A.

537.533.8 : 537.311.33

07. Secondary electron emission from germanium. B. JOHNSON AND K. G. MCKAY. *Phys. Rev.*, **93**, 8–72 (*Feb.* 15, 1954).

Secondary emission by electron bombardment has en measured for single crystals of Ge with *p–n* nctions. Maximum yield was found in the range = 1·15 ± 0·03, at $V_p \simeq 500$ V and room tempera- re. Increasing temperature decreased the yield cause of a small interaction between the internal condaries and the lattice. The most probable ergy of emission was 1–2 eV. There was no change yield with donor or acceptor concentration up to ^{19}/cm^3, and in particular there was no detectable fect of the space-charge fields under the surface. hese results form the basis for discussion of the condary emission process in semiconductors as mpared with metals and insulators. A.

537.533.8 : 621.385.15

608. Methods of processing silver-magnesium condary emitters for electron tubes. P. RAPPAPORT. *appl. Phys.*, **25**, 288–92 (*March*, 1954).

In order to prepare a good secondary electron nitting surface from a silver-magnesium alloy, it was und that baking in dry oxygen would not form the sired surface as originally believed, whereas baking the presence of water vapour did yield a good condary emitter. Subsequent experiments showed at, because of the rapid diffusion of oxygen through ated silver, the magnesium in the alloy was oxidized *situ* without diffusing to the surface to form the quired magnesium oxide layer. With water vapour an oxidizing medium, the diffusion rate of mag- sium through the silver greatly exceeded that of the ater vapour, and a satisfactory surface layer was rmed. A new technique was then devised in which a original water-vapour process formed the desired rface, followed by an oxygen process to oxidize the manent magnesium throughout the volume of the lloy. With the new technique, good secondary nitters are possible which will withstand severe over- eating without the evaporation of magnesium found ith earlier techniques. A.

537.533.8 : 539.166.835

609. Reduction of an integral in the theory of remsstrahlung. A. NORDSIECK. *Phys. Rev.*, **93**, 85–7 (*Feb.* 15, 1954).

A matrix element integral for bremsstrahlung or air production without Born approximation is re- uced to an ordinary hypergeometric function by con- our integration methods. The result is stated for remsstrahlung and for pair production. A.

537.533.9 : 537.534.8 : 539.185

610. Čerenkov radiation. K. TANAKA. *Phys. Rev.*, **93**, 459–60 (*Feb.* 1, 1954).

Cherenkov radiation is investigated for the following cases: charged particles and neutrons moving in isotropic crystals; charged particles moving in an arbitrary direction with respect to the optic axis in uniaxial crystals. A.

537.534 : 537.525.8

4611. On homogeneous energy ion currents from the hollow cathode glow. M. PAHL AND W. KLEINMANN. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 165–77 (1953) *In German.*

Describes experiments in which ions were drawn out from hollow cathode glow discharges in H_2, N_2 and Ne through a 0·5 mm hole in a base plate to which a variable extraction voltage was applied. The ions were then accelerated (300 V–1000 V) and passed through a canal (10 mm long, 1 mm diameter) to give a parallel ($\sim 0{\cdot}1$ μA) beam. The energy of the beam was measured as a function of gas pressure, extraction voltage and discharge current. The narrowest energy distribution was found to occur with zero extraction voltage. J. DUTTON

537.534

4612. Orbit instabilities due to non-linearities in the cosmotron. J. SEIDEN. *C.R. Acad. Sci.* [*Paris*] **238**, 230–2 (*Jan.* 11, 1954) *In French.*

Second-order terms in the equations of betatron oscillation are treated as perturbations on the first-order solution. If ϕ_x, ϕ_z, denote respectively the phase change per revolution for the radial and vertical motion, then whenever any of the quantities ϕ_x, ϕ_z, $3\phi_x$, $3\phi_z$, $\phi_x \pm 2\phi_z$, $2\phi_x \pm \phi_z$ is an integral multiple of 2π the effect of the new terms is cumulative on successive revolutions; this is interpreted as instability. The method applies equally to the conventional and strong-focusing synchrotrons. J. S. BELL

537.534 : 539.172.13

4613. The acceleration of nitrogen-14(+6) ions in a 60-inch cyclotron. G. B. ROSSI, W. B. JONES, J. M. HOLLANDER AND J. G. HAMILTON. Letter in *Phys. Rev.*, **93**, 256–7 (*Jan.* 1, 1954).

The acceleration of $^{14}N^{6+}$ ions in the 60 in. Berkeley cyclotron is reported. Currents of up to 0·1 μA of ions of > 100 MeV energy have been produced. Saturation α-activities of 10^4 to 10^5 counts per minute have been observed in bombarded Pt foils and At isotopes have been identified. At least two iodine isotopes have been produced from Pd, with half-lives around 18·0 and 83·5 minutes. J. H. FREMLIN

537.534.3

4614. Some ions of high kinetic energy in mass spectra of polyatomic molecules. F. L. MOHLER, V. H. DIBELER AND R. M. REESE. *J. chem. Phys.*, **22**, 394–7 (*March*, 1954).

When the lighter-fragment ions of hydrocarbons and hydrocarbon derivatives are recorded with low-ion accelerating voltages, one observes satellite peaks on the high-mass side of the main peaks that come from ions with a fairly homogeneous high kinetic energy. Observations of the satellite peaks of CH_3^+ ions in mass spectra of 13 hydrocarbons and CH_3CF_3 are reported. The kinetic energies range from 1·5 to 3·4 eV and the relative intensities have a wide range of values but are less than the main peak except in benzene. The appearance potential of the satellite

peak is roughly 30 V in most cases while the main peak is observed above 20 V. These high-energy ions are ascribed to doubly-charged molecule ions that dissociate into two singly-charged fragments. The kinetic energy of the pair of fragment ions is in most cases nearly equal to the Coulomb energy of two ions at a distance equal to the greatest distance between valence electrons in the molecule. A.

537.534.3

4615. An all metal a.c. operated radio-frequency mass spectrometer. J. Dekleva. *Bull. sci. Cons. Acad. Yougoslavie*, **1**, 71–2 (*Nov.*, 1953) *In German.*

A Bennett [Abstr. 2503 (1950)] instrument, in a metal envelope, with electrical circuit similar to Townsend's [Abstr. 558 (1953)] is described. The resolving power is 30.

537.534.3

4616. Electron-optical design of a mass-separator. P. A. Sturrock. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. T/M*89, 10 *pp.* (1953).

The design of a magnetic mass-separator which is to focus a line-source into a line-image is investigated; it is assumed that all rays of the beam leave the line-source normally. The curvatures of the entrance and exit boundaries of a uniform magnetic field are adjusted so that broadening of the image due to second-order aberrations is eliminated, and the position of the plane of best focus is determined. The calculations are based on a previous paper [Abstr. 7317 (1952)]. A.

537.534.74

4617. Double scattering of high-energy protons. C. L. Oxley, W. F. Cartwright and J. Rouvina. *Phys. Rev.*, **93**, 806–16 (*Feb.* 15, 1954).

Measurements of polarization effects in double scattering of protons have been made in the energy range near 200 MeV. With a first scattering angle of 19° and a mean second polar angle of 27°, the azimuthal asymmetry 2ε, the fractional difference between second scattered flux at azimuths 0° and 180°, has been determined with several first and second target materials. With a polyethylene second target, an effective hydrogen target was realized by detecting in coincidence the scattered and recoil protons. By successive use of carbon and polyethylene first targets, with an effective hydrogen second target, the asymmetry in double p–p scattering was determined by subtraction to be $9{\cdot}6 \pm 3{\cdot}5\%$. Since the fractional polarization, P, in a single scatter is related to the asymmetry in a double scatter by $2\varepsilon = 2PP'$, the polarizations produced in single scatters from hydrogen and carbon were found to be, neglecting energy degradation and angle change, $P_H = 22 \pm 4\%$ and $P_C = 43 \pm 8\%$. A comparison of the double p–p asymmetry with those calculated by Goldfarb and Feldman using current p–p force models shows that the repulsive core model of Jastrow which best predicts the observed single scattering differential cross-sections yields far too little polarization. Considerable singular non-central force as used in other models seems indicated. The polarized protons produced in scattering from carbon may be useful for other experiments. The polarizations in scattering from several elements in the range from D to Ag, as measured with a hydrogen analyser, vary from 20 to 50%. A.

537.534

4618. Elastic scattering of protons by helium 5·78 MeV. W. E. Kreger, W. Jentschke a P. G. Kruger. *Phys. Rev.*, **93**, 837–42 (*Feb.* 1954).

The differential cross-section for the scattering 5·78 MeV protons by helium has been measured w an accuracy of ± 2%. Scattered protons and rec α-particles were detected in Ilford C-2 nuclear tra plates, allowing the calculation of cross-sections 26 angles from 16·2° to 154° in the centre-of-m system. The differential cross-sections per unit so angle are given as a function of the centre-of-m scattering angle. The results, analysed in terms phase shifts, confirm the large splitting of the inver $P_{\frac{3}{2}} - P_{\frac{1}{2}}$ doublet in Li^5 and indicate the presence o small negative D wave phase shift.

537.534.74 : 537.533

4619. Scattering of high energy nucleons and el trons by carbon. G. Z. Shah, N. J. Patel and K. Gatha. Letter in *Proc. Phys. Soc.* [*London*] *A*, 92–4 (*Jan.*, 1954).

The nuclear scattering of 345 MeV protons and 15 MeV electrons by carbon is analysed. It is fou possible to fit both by assuming a nuclear charge d tribution $\rho = \rho_0$, $r < R_0$; $\rho = \exp\{-(r - R_0)/a$ $r > R_0$. The parameters can have the valu $0 < R_0 < 0{\cdot}6 \times 10^{-13}$ cm, $a \simeq 1 \times 10^{-13}$ cm.

G. E. BROW

537.534.

4620. The stopping powers of various elements protons of energies from 400 to 1050 keV. A. Chilton, J. N. Cooper and J. C. Harris. *Phys. Re* **93**, 413–18 (*Feb.* 1, 1954).

The proton-stopping powers of the elements nitr gen, neon, argon, krypton, xenon, nickel and copp are reported in the energy range from 400 keV 1050 keV. Comparisons are made with results other experimental work and with theory. T measured stopping powers show a dependence particle velocity and on the atomic number of t stopping element in general conformity with the theo of N. Bohr. For proton energies below 700 keV, t ratio of atomic stopping power to $Z^{\frac{1}{3}}$ for nickel a copper is lower than the corresponding ratio for t gases. Energy loss straggling is reported for nick and copper and is of the same order of magnitude theory predicts.

537.533.75 : 537.534.

4621. Influence of chemical state on stopping of fa charged particles. T. Westermark. *Phys. Rev.*, 9 835–6 (*Feb.* 15, 1954).

The suggestion is made to use the characteris electron dispersion frequencies or corresponding wav lengths (λ_0) from molar refraction data for the pr diction of influences of the chemical state on t stopping power of fast charged particles. Changes λ_0 for atoms in different chemical states are tran formed into changes in mean excitation potentia in the Bethe–Bloch theory and to changes in stoppi power. Mass absorption data for Bi^{210} β-rays Fournier are corrected for the anomalous Z/A-fact for hydrogen and then show the predicted effects f different groups of hydrocarbons. The very accura

ta by T. J. Thompson on fast protons are compared with those from the "λ_0 approach" for a number of cases. Qualitative agreement is present for most of them but quantitatively the situation is less satisfactory. Certain favourable cases of large anomalies, not yet investigated, are predicted. A.

537.534.75 : 778.34

22. Experimental determination of the range-energy relation of "nuclear" emulsions of different compositions. Comparison of stopping powers of these emulsions. L. VIGNERON AND G. PHILBERT. *C.R. Acad. Sci.* [*Paris*] **237**, 1675–7 (*Dec.* 21, 1953) *In French.*

Ranges and straggling in Ilford C2 emulsions with 1·8, 73·3, 65·5% of halogens were compared by impregnation with α-active materials. Results agree with calculations of abstract following.

W. J. SWIATECKI

537.534.75 : 778.34

23. Calculation of the range-energy relation for different compositions of photographic emulsions. Comparison with experimental determinations. M. OGAARDT AND B. KOUDIJS. *C.R. Acad. Sci.* [*Paris*] **237**, 1678–9 (*Dec.* 21, 1953) *In French.*

Using theoretical ionization potentials for H, C, N, O, S and empirical ion. pot. for Br, Ag and I in Bethe's stopping formula it was possible to calculate range-energy relations (α's up to 10 MeV) for Ilford C2 emulsions with different proportions of gelatin. [See preceding abstract.] W. J. SWIATECKI

537.534.9

24. Sputtering of alkali atoms by inert gas ions of low energy. R. C. BRADLEY. *Phys. Rev.*, **93**, 19–28 (*Feb.* 15, 1954).

Direct measurements of sputtering have been made using alkali metal targets bombarded by inert gas ions in a high vacuum, the sputtered atoms being counted by a surface ionization detector. Measurements were made in the range 0–1800 eV ion energy for the ions He^+, Ne^+, A^+ and Xe^+ incident upon Na and K target surfaces. Secondary electron coefficients γ were measured simultaneously. It was found that over most of the energy range covered, the measured sputtering coefficient θ' (number of sputtered atoms reaching the detector per positive ion incident on the target) was linear in $\ln E$ for He^+ and Ne^+ and in $\sqrt{E}$ for A^+ and Xe^+, where E is the ion energy. At energies less than about 150 V the sputtering rate appeared to be controlled by the amount of kinetic energy which could, on the average, be transferred to a single surface atom in a direct two-body collision. Thus at low energies Ne^+ produced the most sputtering from a Na surface, whereas A^+ produced the most from a K surface. At high energies, the sputtering rate was in the same order as (but not proportional to) the mass of the ion. The effect of surface contamination was also studied. An old surface showed a lower sputtering coefficient than a fresh surface and a higher and more erratic secondary electron coefficient, the effect being most pronounced for the light ions. The absolute sputtering coefficient θ (total number of sputtered atoms per incident ion) could not be measured directly, but it was estimated from the geometry that for 1000 V ions the value of the coefficient ranged from about 1·0 for Xe^+ on K to 0·05 for He^+ on Na. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

4625. Operating conditions in a high-frequency ion source. M. DE L. LAREYMONDIE, J. SALMON AND J. WAJSBRUM. *J. Phys. Radium*, **15**, 117–21 (*Feb.*, 1954) *In French.*

The characteristics of the high-frequency ion source of the type developed by Moak, Reese and Good are examined experimentally. The variation of output ion current with gas pressure, extraction voltage and high-frequency power input are given. Optimum values of these parameters for maximum output occur. Ion currents up to 1 milliampere are obtained, 75% being protons. The effective source diameter is about 1 mm. M. E. HAINE

537.542

4626. Spurious random pulses in Geiger–Müller counters. R. SEIDL. *Czech. J. Phys.*, **1**, *No.* 3–4, 160–70 (1952).

Spurious random pulses were found which are independent of external radiation, depending exponentially on the voltage above the threshold of sensitivity of the counter and on the reciprocal value of the absolute temperature. It is shown that the assumption of chemical reactions taking place on the surface of the cathode theoretically leads to an identical dependence on the temperature. By calculation one can find the numerical values of the activating energies of chemical reactions or the work function of the metals of the cathode materials. A.

537.542

4627. An investigation of discharge quenching and post-discharge phenomena in Geiger–Müller counters using X-ray impulses. P. MÜLLER. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 110–35 (1953) *In German.*

The paper describes detailed measurements, using short X-ray pulses, of dead times and recovery times with a special study of the discharges found to follow a triggering pulse. With reference to these post-discharge effects, the relevance of secondary emission, negative ions and metastable atoms are discussed. Exptl. methods and results are given in some detail, with typical oscillograms. J. D. CRAGGS

537.542

4628. Evaluating beta energy dependence in end-window G–M tubes. U. L. UPSON. *Nucleonics*, **11**, 49–54 (*Dec.*, 1953).

The relative counting efficiencies, at different distances from the window of a G.M. counter set up over a shelf assembly, were determined for sources of RaE, Pm^{147}, Tl^{204} and Y^{91} with glass/aluminium or Pt backings. The results were compared with efficiencies calculated from the geometry of the arrangement. The more energetic sources gave relatively greater efficiencies and the softer β-sources relatively lower efficiencies at increasing distances from the counter window. It is shown that

this energy dependence of counting efficiency variation with distance can be used to obtain absolute estimates of source strengths. L. R. SHEPHERD

537.542

4629. Velocity of discharge propagation in self-quenching Geiger–Müller counters. P. A. C. MORTIER AND J. F. ROOSE. Note in *Proc. Phys. Soc.* [*London*] *B*, **67**, 161–3 (*Feb.*, 1954).

Gives exptl. data for noble gas—ethyl alcohol counter fillings. The values for argon-ethyl alcohol are given in more detail. Propagation speeds vary from 1·6 to 6·6 cm.μsec^{-1}. J. D. CRAGGS

537.542

4630. Response of a pulsed Geiger tube. H. B. ROSENSTOCK. *J. appl. Phys.*, **25**, 275–81 (*March*, 1954).

For the purpose of extending the usefulness of a Geiger counter to higher radiation intensities, it has been suggested that the voltage applied to its electrodes be a periodically repeated pulse rather than the usual d.c. If the duration of the pulse is of the order of the spread time of the discharge in the tube, the output current *v.* radiation intensity relation will differ from the usual linear one, largely because the resulting current surge may not reach its maximum before the end of the applied pulse. This relation will therefore depend, among other factors, on the not fully understood mechanism by which the discharge spreads. Using probability considerations, this relation is calculated as a function of the response of the tube under ordinary operation. If the discharge spreads rapidly (e.g. exponentially) initially, an approximate general relationship not involving the detailed spread mechanism may be established. The response to be expected in two types of tubes is discussed in detail, using models for the spread mechanism which are mathematically simplified though probably physically adequate. A.

537.542

4631. The correction formula for the dead time of a Geiger–Müller counter. J. W. HUGHES. Letter in *J. sci. Instrum.*, **31**, 111 (*March*, 1954).

It is pointed out that the effect described by Wyard [Abstr. 2514 (1954)] has been taken into account in the quenching circuit of Eastabrook and Hughes [Abstr. 8472 (1953)]. In it a diode "clamp" in parallel with the counter resistor serves to prevent the rise in mean counting potential with counting rate.

537.542

4632. Ionisation-chamber device for clinical gamma-ray use. M. A. BULLEN. *Nucleonics*, **11**, 15–17 (*Dec.*, 1953).

Air-filled ionization chambers constructed in an annular form around a cylindrical cavity are described. The sample whose γ-ray activity is to be determined, is placed inside the cavity. The saturation current through the chamber is measured by the voltage drop across a resistor using a modified Dolezalek quadrant electrometer set up in such a way as to give a linear voltage response. L. R. SHEPHERD

537.542 : 539.172.4

4633. A neutron-sensitive ionization chamber with electrically adjusted gamma compensation. H. S. MCCREARY, JR AND R. T. BAYARD. *Rev. Instrum.*, **25**, 161–4 (*Feb.*, 1954).

The use of neutron-sensitive ionization chamb for neutron flux measurement in nuclear reactors discussed along with the limitation in neutr detection range because of the γ-ray backgroundl which the chamber must operate. Means of extendi this range are also discussed and a new type of co pensated ionization chamber is described. T compensation adjustment of this new chamber made electrically rather than mechanically as in pr compensated chambers. The extension in neutr detection range over that of an uncompensa chamber is of the order of two decades. Frequ adjustment of the compensation is not necessary sin the drift is small over a long period of time.

537.542 : 548.7

A crystal counter for X-ray crystallography. *Abstr.* 5141

537.5

4634. Development of a proton scintillation spectr meter. F. P. G. VALCKX AND P. M. ENDT. Letter *Physica*, **19**, 1140–2 (*Nov.*, 1953).

An improved form of NaI crystal scintillati counter is developed. Deterioration of the NaI prevented by sealing off with a 15 μ Al window whi is supported by the crystal face. A piece of N metal in the crystal container removes surface spo on the crystal, thought due to vapours from t araldite sealing cement. A corrected half-width 4·1% is obtained for 7·3 MeV protons which cou be improved by using a better photomultiplier [s Abstr. 7470 (1952)]. G. F. J. GARLIC

537.5

4635. Properties of long columns of scintillati liquids. W. A. SCHNEIDER, J. HERSHKOWITZ AN H. KALLMANN. *Nucleonics*, **11**, 46–8 (*Dec.*, 1953).

The light output from a long column of a solutio of terphenyl in phenylcyclohexane with traces diphenylhexatriene excited by cosmic-ray particle was investigated. A telescope arrangement provide by two scintillation detectors in coincidence triggere the beam of an oscillograph whenever a partic passed down the length of a column. A trace wa produced on the screen, proportional to the size the pulse from a photomultiplier placed at one en of the column. The optimum length of the colum was found to be 60 cm with this particular scintillatin solution. L. R. SHEPHER

537.54

4636. Photocathode uniformity and resolution scintillation spectrometers. T. F. GODLOVE AN W. G. WADEY. *Rev. sci. Instrum.*, **25**, 1–4 (*Jan.*, 1954)

Sixteen photomultiplier tubes have been studied t determine the relation between the uniformity of thei photocathodes and the resolution obtained from γ-ray scintillation spectrometer using each of them The sensitivity contours of the tubes have been plotted The resolution was found to be related to the averag sensitivity but could be improved by concentratin the light on the most sensitive part of the photo cathode. Techniques for studying sensitivity with a artificial light flasher are described. A

537.542

37. Detection of 2·5-MeV neutrons with a single-stal scintillation counter. R. E. SEGEL, C. D. ARTZ AND G. E. OWEN. *Rev. sci. Instrum.*, **25**,)–4 (*Feb.*, 1954).

The spectrum of pulse heights from a stilbene ntillation counter exposed to approximately mono- ergetic neutrons is subject to a number of inherent tortions. It is shown that the neutron energy and ensity can be determined rather simply by proper alysis of the experimental data. The reduction of ckground by various types of collimation is scribed. A.

537.542 : 539.166.08

38. A scintillation pair spectrometer. H. I. EST, JR AND L. G. MANN. *Rev. sci. Instrum.*, **25**, 9–35 (*Feb.*, 1954).

A spectrometer involving the use of three NaI(Tl) ystals has been developed which has a high rejection all unwanted pulses. As in the usual scintillation ir spectrometer, the γ-rays pass into a centre ystal and the pair events are selected by detecting e two annihilation quanta in two side crystals. igh rejection of unwanted coincidences is obtained y using a cathode-ray tube differential discriminator t on the photoelectron peaks of the annihilation uanta in the side crystals, along with coincidence rcuits of moderately good resolution (0·15 μsec). this way pair distributions from Na^{24} (1·38 and ·76 MeV) and Co^{60} (1·17 and 1·33) have been bserved with almost no background. The apparatus as also been found useful in many other scintillation ounter applications involving energy differentiation nd coincidence counting. A.

537.542

639. Study of RCA 5819 and EMI 6260 photo-ultipliers as individual photon counters. L. COLLI, J. FACCHINI AND A. ROSSI. *Nuovo Cimento*, **11**, 55–61 (*March*, 1954).

The behaviour of these photomultipliers as ndividual photon counters is described. Measure- ents were made of the spectrum and the intensity f the background pulses at room temperature and at lower temperature corresponding to cooling by ry-ice and acetone mixture. The sensitivity to hotons of wavelength of about 5500 Å was found, t room temperature: 600–2400 photons per sec and er cm^2; with cooled dry-ice acetone mixture: 30–120 hotons per sec and per cm^2. A.

537.542 : 621.374.3.018.75

1640. Effect of steepness of pulse fronts on the esponse of differentiating and integrating circuits. 3. K. BHATTACHARYYA. *Indian J. Phys.*, **27**, 269–83 *May*, 1953).

A study is made of the responses of integrating and differentiating circuits to a pulse front that rises inearly up to a certain time and then flattens out. Such circuits are generally analysed by assuming the nput pulse to be a step-function. That the responses obtained by such an analysis differ greatly from those found in the case of a linearly rising pulse that flattens out after a certain time, is shown clearly in both cases of cascaded differentiating and integrating circuits. When the rise time is very short, the output pulse shape becomes similar to that in the case of step-function input pulse. As the rise time and the number of cascaded sections increase, the magnitude as well as the rate of rise of the integrated output pulse begin to diminish sharply. In the case of differentiation, the maximum output voltage depends very much upon the rise time. A.

537.542 : 621.374.32

4641. A decade scaling circuit. R. ISHIWARI AND K. YUASA. *Mem. Coll. Sci. Univ. Kyoto A*, **25**, 155–8 (*Dec.*, 1949).

This paper describes a variation of the conventional hard-valve scale-of-ten counting circuit. The basic scale-of-sixteen circuit is modified to a scale-of-ten by the addition of two triodes which provide the necessary feed forward to advance the count. A detailed circuit with component values is given. D. R. CHICK

537.542 : 621.374.32

4642. Applications of kicksorters. G. W. HUTCHINSON. *Trans Instrum. Meas. Conf.*, **1952**, 153–6.

The energy resolution available from the different detectors used with pulse-height analysers was estimated as 1% and the effect of the detector resolution on the kicksorter circuit design was discussed and the need for analysers of three types was reviewed. The multi-channel kicksorter described used a delay line as a memory element, the pulse sizes are sorted by comparing the peak amplitude against a sawtooth waveform, thus converting the voltage into time measurement. The spectrum is displayed as a number of pulses in each channel in a binary scale against pulse size on c.r.t. At a given speed of operation, the storage capacity per channel (number of binary digits) and the number of channels is roughly proportional to the length of the delay line, and thus inversely proportional to the maximum counting rate. The choice can be made in both cases by a single switch. Although the maximum counting rate is limited by the delay-line length, pulses can be fed into the kicksorter at a much higher rate without distorting the spectrum. This is because the kicksorter is arranged to take a random pulse sample independent of pulse sizes. Errors due to this gating circuit taking random samples are discussed and means of eliminating them are described. The use of delayed coincidence counting in half-life experiments is discussed and circuits are given for using pulse size analysis in half-life and time-of-flight experiments. The application of the kicksorter to angular correlation experiments is reviewed and the factors effecting the real to random ratio of coincident counts are given; emphasis is placed on the improvement to be obtained in this ratio by using low detector background and small number of total counts in both detectors. D. R. CHICK

537.542 : 621.374.32 : 621.317.79

4643. A multichannel pulse-height and delay time recorder. W. C. G. ORTEL. *Rev. sci. Instrum.*, **25**, 164–9 (*Feb.*, 1954).

An instrument is described which records both the height of a voltage pulse from a scintillation counter and the delay time between this pulse and a pulse from a BF_3 neutron counter. For each scintillation pulse, a delayed pulse is produced whose delay time is a

linear function of the scintillation pulse height. This delay time and the neutron delay time are recorded in binary notation on a moving paper chart. Pulse heights are recorded in forty channels and neutron delay times in fifteen channels. A.

537.542 : 621.387 : 621.373.432

4644. An efficient arrangement for tripping, without auxiliary electrode, a flash tube for Wilson chamber experiments. A. ROGOZINSKI. Letter in *J. Phys. Radium*, **15**, 123 (*Feb.*, 1954) *In French.*

Describes a simple flash tube circuit in which the breakdown of a mercury vapour tube, in series with the main flash tube, triggers the latter. J. D. CRAGGS

537.543 : 621.385.1

4645. Potential distribution and prevention of a space-charge-induced minimum between a plane secondary electron emitter and parallel control grid. G. C. SPONSLER. *J. appl. Phys.*, **25**, 282–7 (*March*, 1954).

Formulae are developed which define the profile of the electrostatic potential distribution in the semi-infinite, space-charge-filled region between a plane emitter of secondary electrons and a parallel retarding-field control grid. The calculation assumes a known secondary-electron energy distribution and a cosine angular distribution. In practical application, the formulae must be evaluated numerically or graphically since the energy distribution cannot be expressed analytically except over limited regions. A method of determining the critical spacing between electrodes which will prevent formation of a space-charge-induced minimum in the potential distribution between the emitter and control grid is presented. A.

IONIZATION . THERMIONICS 537.56/.58

537.56/.57

4646. The density effect for the ionization loss at low energies. R. M. STERNHEIMER. Letter in *Phys. Rev.*, **93**, 351 (*Jan.* 15, 1954).

The author's previous calculations of the stopping power of gases [Abstr. 932 (1953)] used values of the mean ionization potential I_{BS}, derived from the measurements of Bakker and Segrè [Abstr. 4456 (1951)]. As the density effect in gases is negligible, the ionization potential for the isolated atom, I, should have been used, since I_{BS} includes the density effect. Estimates of the necessary correction show its magnitude to be hardly outside the limits of experimental error. J. HUGHES

537.563 : 551.594.12

4647. Production of unipolar air with radium isotopes. T. L. MARTIN, JR. *Commun. and Electronics*, *No.* 10, 771–6 (*Jan.*, 1954).

Unipolar air is air that contains ions of only a single polarity. There are many industrial applications in which it is necessary or desirable to have facilities for discharging electrified particles that adhere to materials or machines. A general survey is given of recent development work on sources of unipolar air using α-emitting radioactive materials. Spec reference is made to a new device, operating at r tively high air speeds of about 450 ft/min, which provide an air output containing only positive only negative ions. The method of controlling density of this unipolar output is also treated.

537.

4648. On the ionization and on the Cherenkov rad tion [produced by high-energy ionizing particl P. BUDINI AND L. TAFFARA. Letter in *Nuovo Cimen* **10**, 1489–92 (*Oct.*, 1953) *In Italian.*

The formulae previously given by one of authors [Abstr. 1394 (1954)] are discussed a applied to the evaluation of the number of prim ions in hydrogen as a function of the ionizing parti energy for various values of the pressure.

L. PINCHER

537.564 : 537.53

4649. Ionization of gas by electrons. J. K. KNI T. EGUCHI, M. OHTA AND S. NAGATA. *Progr. the Phys.*, **10**, 24–30 (*July*, 1953).

A statistical analysis is made for the number ions produced by an electron when it is absorb in a hydrogen gas. The average number and the me square fluctuation of the ion pairs as functions of t incident energy of electron satisfy inhomogeneo linear integral equations which yield Fano's results the first approximation.

537.564 : 551.594

Excitation processes in the aurora and airglow. *S Abstr.* 5190–1

537.5

4650. The movement of charge carriers in no homogeneous fields. W. BEZ AND K.-H. HÖCKE *Z. Naturforsch.*, **9a**, 64–6 (*Jan.*, 1954) *In German.*

A theoretical paper dealing briefly with the dr velocities of charged particles, and their energy random motion, in discharges, etc. Special referen is made to the anode fall region. J. D. CRAG

537.56

4651. A microwave investigation of the ionizati of hydrogen-oxygen and acetylene-oxygen flame K. E. SHULER AND J. WEBER. *J. chem. Phys.*, 2 491–502 (*March*, 1954).

The ionization of premixed hydrogen–oxygen an acetylene–oxygen flames burning at atmospher pressure was studied by a microwave metho The attenuation of electromagnetic radiation by th flames was employed to determine the free electro concentration. To obtain a high sensitivity for thes measurements, a microwave bridge operating slightl off balance was employed, with the flames positione between two electromagnetic horns in one of th bridge arms. This method permits the determinatio of electron densities down to about 5×10^8 electron per cm^3 at atmospheric pressure. In interpreting th data obtained in this study it was found necessar to take a quantitative account of the "backgroun ionization" resulting from the presence of alkali sal as contaminants in the air and the flame gases. Afte the appropriate background measurements and co rections were made, it was found that the ionization c

hydrogen–oxygen flames and of lean and stoichiotric oxy-acetylene flames was thermal and agreed ll with the electron concentration values obtained m equilibrium calculations using the adiabatic me temperatures. A complete equilibriation and uipartition of the internal energy for H_2–O_2 flames indicated by the good agreement between the ective ionization temperature and the rotational, otational, and electronic temperatures determined eviously. The background-corrected ionization of e rich acetylene–oxygen flames ($C_2H_2/O_2 = 1{\cdot}5/1$ to 1) was found to be higher by a factor of 10 to 100 an that calculated for a purely thermal flame nization. This can very plausibly be accounted for n the basis that the high electron concentration in ese rich hydrocarbon flames is primarily due to the ermal evaporation of electrons from the carbon atom ggregates (soot particles) formed in these flames. calculation showed that a work function of 8·5 eV r the small carbon particles in the flame accounts ell for all the observed electron concentrations. This alue stands in a reasonable relationship to the ionization potential of gaseous carbon atoms (11·265 eV) nd the work function of graphite (4·35 eV). It is uggested on the basis of these results that the ionization in hydrogen–oxygen and acetylene–oxygen ames, at least as far as the hot combustion gases are oncerned, is an equilibrium process which can be ccounted for by purely thermal considerations. Whether or not this holds true also for the reaction one proper must remain open to question for the resent, since the measurements described here ertain by necessity to an ionization density averaged ver a rather extensive region of the flame. A.

537.568 : 537.22

4652. Charging of an insulated tube by the passage through it of ionized air and absorption of the ions. R. Siksna and A. Metnieks. *Z. angew. Phys.*, **5**, *No.* 12, 454–61 (1953) *In German.*

Describes measurements of the absorption of ions by the outer electrode of a cylindrical condenser as a function of the applied voltage V when air containing ions (produced by u.v. light, heated filament or corona discharge) is drawn through the cylinder. The effect of the rate of flow of air on the absorption was also investigated. Theoretical expressions for the absorption when $V = 0$ are obtained by assuming (1) that the absorption is due to image force attraction of the ions to the walls and (2) that it is due to diffusion of ions to the walls. The latter gives good agreement with experiment. J. DUTTON

537.583

4653. On the electron bombardment effect for deposited barium oxide films. T. Imai. *J. Phys. Soc. Japan*, **9**, 28–37 (*Jan.–Feb.*, 1954).

Several phenomena caused by electron bombardment of barium oxide films deposited from an oxide-coated cathode are described. The oxide cathode used as electron source is largely deactivated by electron bombardment of the deposited film. The origin of emission decay is found to be due to evolved gas from the deposited film under bombardment. Details of change of the deposited film's activity under bombardment are described. Emission of the film increases or decreases by electron bombardment according to whether deposition is carried out at low or at high cathode temperature. Change of work function is also measured. In connection with the electron bombardment, temperature effects for films are studied and an activation or a deactivation phenomenon found. These results, obtained for nickel and molybdenum sleeves, are applicable for the case of grid emission in commercial tubes. A.

537.583

4654. Transient phenomenon in the oxide cathode layer. T. Shindo. *J. Phys. Soc. Japan*, **9**, 38–43 (*Jan.–Feb.*, 1954).

In a previous paper [Abstr. 558 (1954)] it was shown by the writer that the space charge may be formed in the oxide cathode layer near the surface. The theory is extended to clarify the transient phenomenon in an oxide layer forming this space charge. The theory shows some short-time transient phenomena having 10^{-8}–10^{-9} sec transit time. A.

537.583 : 535.231.4

4655. Thermionic emission and optical emissivity of zirconia. G. Mesnard. *Vide*, **8**, 1392–9 (*July–Sept.*, 1953) *In French.*

Experimental study showing that zirconia behaves in the same general way as thoria but gives considerably less thermionic emission. A. H. W. BECK

537.583 : 621.385.032.216

4656. The thermionic emission from thin films of barium and strontium oxide. J. Woods and D. A. Wright. *Brit. J. appl. Phys.*, **5**, 74–6 (*Feb.*, 1954).

Evaporated films of BaO and SrO were studied. Thin BaO films have a good emission following evaporation. The emission improves a little during heat treatment, and is then similar to that from a sprayed cathode coating of BaO. There is a maximum emission at a thickness of 10^{-5} cm. SrO behaves similarly, with a lower level of emission. If BaO is evaporated on SrO, the best emission obtainable is as for BaO alone. If, however, SrO is evaporated on BaO, heat treatment results in an emission higher than that from either BaO or SrO alone, and similar to that from a sprayed cathode coating of mixed BaO and SrO. The emission is best when the SrO thickness is 10^{-5} cm, whether the BaO thickness is of this order or greater. A.

537.585

4657. Negative ion emission from oxide-coated cathodes. I. F. A. Vick and C. A. Walley. *Proc. Phys. Soc.* [*London*] *B*, **67**, 169–76 (*March*, 1954).

A simple glass-envelope mass spectrometer of the 90° deflection type is described. Its resolving power $\delta M/M$ is 0·00925, which is adequate for ions up to about $M = 50$. The dominant negative ions emitted from oxide cathodes are found in many cases to be chlorine, and it is shown that these often originate from the glass when baked to about 450°C, confirming the conclusions reached by Hamaker, Bruining and Aten. The chlorine ion emission is correlated with the poisoning of the cathode. Preliminary observations on other ions, $M = 16$, 26, 32, 42 and 44, are recorded and discussed. A.

537.585

4658. Negative ion emission from oxide-coated cathodes. II. W. GRATTIDGE AND A. A. SHEPHERD. *Proc. Phys. Soc.* [*London*] *B*, **67**, 177–86 (*March*, 1954).

Describes a detailed study of negative ion emission processes from oxide cathodes during all stages of cathode life, using two types of mass spectrometer having oxide cathode sources. The main ions found were those of mass numbers 12, 16, 26, 27, 32, 35, 37, 42 and 43. A retarding potential method was employed to determine energy distributions of all the ions, and special attention was paid to ions emitted during activation, it being found that any oxygen evolved during activation was in an uncharged state. Variations in ion emission due to cathode temperature and applied field were also studied. A.

COSMIC RAYS 537.591

537.591 : 539.18

4659. International Congress on Cosmic Radiation at Bagneres de Bigorre. M. M. SHAPIRO. *Science*, **118**, 701–7 (*Dec.* 11, 1953).

Summarizes the results presented at the Congress (July, 1953), which was concerned with "elementary" particles and high-energy interactions. The revised nomenclature for unstable particles which was proposed there is not described or fully used in the report because still under discussion.

537.591.1

4660. Ionization spectrum of cosmic-ray particles in the stratosphere. N. L. GRIGOROV, I. D. RAPOPORT AND G. P. SHIPULO. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 491–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-123.

The ionization spectra for the soft and hard components of the cosmic rays at balloon altitudes have been measured using an ionization chamber in coincidence with counters. Curves are given showing the increase in ionization with altitude. H. ELLIOT

537.591.1

4661. An investigation of the non-ionizing component of cosmic rays in the stratosphere. V. S. ZARYA, YU. A. SMORODIN AND Z. I. TULINOVA. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 495–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-103.

The photon component has been studied by investigating the production of ionizing particles in a 1 cm lead plate carried aloft by balloons. It is concluded that the number of photons is $\sim 50\%$ of the number of electrons which agrees fairly well with the calculated value of 65%. H. ELLIOT

537.591.1

4662. The electron component and the origin of cosmic rays. V. L. GINZBURG AND M I. FRADKIN. *Dokl. Akad. Nauk SSSR*, **92**, *No* 3, 531–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-159.

The absence of electrons in the primary cosmic ray flux is discussed in relation to interstellar magnetic fields and it is concluded that the cosmic-ray electr are lost because of radiation in these fields. Assum a field of $\sim 10^{-5}$ gauss it is shown that no electr of energy greater than 5×10^{8} eV are likely to present in the primary flux. H. ELL

537.59

4663. On the identification of charged cosmic-particles stopping in electron-sensitive emulsic I. Singly-charged particles. G. KAYAS. *J. Ph Radium*, **15**, 34–8 (*Jan.*, 1954) *In French.*

Two methods have been used for the identificat of singly-charged cosmic-ray particles (π, μ-mes and protons) near the end of their range in nucl emulsion: (*a*) gap counting, and (*b*) δ-ray counti The accuracy of mass measurements using the t methods is discussed. H. ELL

537.59

4664. Neutron measurements at great undergrou depths. J. EUGSTER. *Rev. sci. Instrum.*, **25**, (*Jan.*, 1954).

A preliminary report on first extensive measu ments of the cosmic-ray intensities at medium und ground (5880 m w.eq.) is given. In these experimen carried out during 1951 and 1952, two identi portions of photographic plates, one bare and c shielded with Cd, were exposed at identical tempe ture. For the controls, which were exposed at surface of the earth, there was found a good agreem between the results and those obtained by Yag and Kaplan for slow neutrons. The Cd differen counts obtained at the underground station w much higher than the controls.

537.59

4665. The interaction and production of cosmic-r protons in carbon. J. BALLAM AND P. G. LICHTE STEIN. *Phys. Rev.*, **93**, 851–7 (*Feb.* 15, 1954).

Protons in the cosmic radiation at sea level w observed under varying thicknesses of carb absorber. In the energy range 150 to 570 MeV interaction mean free path for protons was estimat from the ratio of those emerging from the absorber those incident upon the absorber and is greater th 140 g/cm^2 in carbon. The spectrum of proto produced in the carbon by neutral cosmic radiati permits the inference of the flux of neutrons in t cosmic radiation, with the result that neutrons wi momenta greater than 550 MeV/c are 6% as abunda as all ionizing cosmic radiation at sea level.

537.591

4666. Differential range spectrum of cosmic-r mesons at sea level. P. G. LICHTENSTEIN. *Phys. Re* **93**, 858–60 (*Feb.* 15, 1954).

Operation of a cosmic-ray mass-measuring equi ment under 8·8 in. of carbon absorber for 123 hr sensitive time yielded 495 stopping mesons identifiab by their momentum v. residual range. After correcti for zenith-angle and solid-angle dependence of t stopping particles, it is found that the spectrum μ-mesons for residual ranges 40–105 g/cm^2 air equ valent is flat and has an intensity of approximate $6{\cdot}0\times10^{-6}$/g.sec.sterad. It is shown that the resul of York, when corrected for a very heavy backgrou of electrons at small ranges, yield a μ-meson spectru in good agreement with the present work.

537.591.1

7. On the fragmentations of heavy cosmic ray lei. K. GOTTSTEIN. *Phil. Mag.*, **45**, 347–59 (*April*, 4).

n photographic emulsions exposed at 95 000 ft reactions of heavy nuclei ($Z \geqslant 3$) with the nuclei the emulsions have been studied. The charges and rgies of the cosmic-ray nuclei were determined th "directly" from their multiple scattering and ay densities, or from the variation of δ-ray density th range, and "indirectly" by measuring the ening angles of the showers of fragments, and the al energy released in the reactions. A survey is en of the different types of reactions observed. ie observed frequency of occurrence of heavy gments ($Z \geqslant 3$) produced in the encounters of avier nuclei is in accordance with the results tained by Peters *et al.* The charge distribution at e top of the atmosphere is calculated from the one easured below material (air, glass, emulsion) rresponding to 15–40 g/cm² of air, using the collision oss-section as found by Peters. The influence of nergy loss by ionization is considered. The resulting harge distribution is in approximate agreement with ie one measured by Dainton, Fowler and Kent, the uclei Li, Be, B being about as frequent as C, N, O, F. he energy distribution agrees with the one obtained y Dainton, Fowler and Kent. The frequency of eson production in collisions of heavy nuclei is udied. A.

537.591.1 : 523.165

668. Theory of origin of cosmic rays. E. TELLER. *Rep. Progr. Phys.*, **17**, 154–72 (1954).

Primary cosmic rays consist of fast protons and eavier nuclei. The dependence of the number of osmic rays on their energy and the relative abundance f the various nuclear species, together with the sotropic distribution of the cosmic radiation, has to e explained by any theory of cosmic rays. It is hown that a random acceleration process, proposed y Fermi, and a physical location of the accelerating ields in radio stars, proposed by Unsöld, account atisfactorily for the main features of cosmic radiation. A.

537.591.15

4669. Study of electron-nuclear showers and penetrating particles in the stratosphere at various latitudes. S. N. VERNOV AND A. N. CHARAKHCHYAN. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 3, 487–90 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr-102.*

The intensity of the hard component penetrating 20 cm lead and the frequency of penetrating showers as a function of altitude has been investigated at geomagnetic latitudes 51° N, 31° N and 2° S using counter sets carried by balloons. It is shown that for primary particles with energy greater than 7 BeV the production of protons in showers increases rapidly with energy. H. ELLIOT

537.591.15

4670. Showers of at least two electrons produced in lead by cosmic rays. C. MILONE. Letter in *Nuovo Cimento*, **10**, 1744–6 (*Dec.*, 1953) *In Italian.*

The air-lead transition curve for electron- and photon-initiated showers was investigated by a coincidence counter technique. At the maximum of the transition curve the ratio $[f(n \geqslant 2)]/[e(n \geqslant 2)]$ was $1{\cdot}8 \pm 0{\cdot}4$, where $f(n \geqslant 2)$ and $e(n \geqslant 2)$ are the number of showers initiated by photons and electrons respectively. J. HUGHES

537.591.15

4671. Fluctuations in the transition curves of cosmic ray electrons. L. BERTANZA AND G. MARTELLI. *Nuovo Cimento*, **11**, 217–30 (*March*, 1954).

Results of a research designed to investigate the electromagnetic cascade are given. Transition curves of cosmic-ray electrons at sea level have been determined with a great accuracy, using various thicknesses of lead. The results for showers containing at least n particles ($n = 1, 2, 3, 4$) are compared with the theoretical curves deduced from the Arley cascade model. The experimental results show that the fluctuation distribution fits considerably better the Pólya rather than the Poisson distribution. A.

537.591.15

4672. On the dependence of the ratio photons/electrons in cosmic-ray showers on average density of selected showers. C. MILONE. *Nuovo Cimento*, **11**, 241–9 (*March*, 1954) *In Italian.*

Experiments were performed at the sea level, by means of G.M. counters, to study the variation of the ratio photons/electrons (f/e), in the extensive air showers of cosmic-rays, as a function of the average density, Δ. The results obtained with three different methods show that the ratio f/e is slightly smaller than unity and decreases slowly when the average density of the showers decreases from about 40 to about 3 particles/m². A.

537.591.15

4673. On meson jets in nuclear emulsions. G. BERTOLINO, A. DEBENEDETTI, G. LOVERA AND M. VIGONE. Letter in *Nuovo Cimento*, **10**, 991–2 (*July*, 1953) *In Italian.*

Twenty-three meson showers (jets) were observed in G5 plates exposed at the height of 22 km. A statistical analysis is given of the number of particles in a jet as a function of the estimated primary energy. The data support the subdivision of these jets into two groups. L. PINCHERLE

537.591.5

4674. Study of the angular distribution and east-west asymmetry of the nucleon component of the cosmic radiation near the equator using sensitive emulsions. TSAI-CHÜ AND M. MORAND. *C.R. Acad. Sci.* [*Paris*] **237**, 1517–19 (*Dec.* 9, 1953) *In French.*

The zenith angle distributions for slow protons at the equator can be represented by the expression $j(\theta) = j(0) \cos^{\lambda} \theta$ where λ increases with energy from $0{\cdot}3 \pm 0{\cdot}1$ to $2{\cdot}1 \pm 0{\cdot}2$. The east-west asymmetry is largest for zenith angles between 30° and 45°. H. ELLIOT

537.591.5

4675. The zenith angle dependence of cosmic-ray protons. C. E. MILLER, J. E. HENDERSON, D. S. POTTER, J. TODD, JR, W. M. SANDSTROM, G. R. GARRISON, W. R. DAVIS AND F. M. CHARBONNIER. *Phys. Rev.*, **93**, 590–5 (*Feb* 1, 1954).

The proton spectrum for particles in the momentum band 0·4–1·0 BeV/c and the meson spectrum for

particles in the momentum band 0·09–0·34 BeV/c at zenith angles 45° east, vertical, and 45° west have been obtained at 3·3 km elevation and magnetic latitude 48° north. The zenith angle dependence of protons, along with a simplified analysis, is presented as data on the nucleonic cascade. It is found that the gross zenith angle dependence will fit a $\cos^{3.2}\theta$ distribution at 45° east and west, there being no statistically significant east-west asymmetry. The simplified calculation assumes that a unidirectional component of the primary radiation will (1) suffer exponential absorption along its original path with a path length for removal of 120 g/cm² of air, and (2) acquire an ultimate distribution at 3·3 km due to scattering fitting a $\cos^n \omega$ law, n being an adjustable parameter. It is found that a value of n of $6{\cdot}5 \pm 0{\cdot}7$ yields a unidirectional distribution which, when integrated over all angles, results in a gross zenith angle dependence agreeing with $\cos^{3.2}\theta$. The $\cos^n \omega$ distribution with n equal to 6·5 is quite sharp and leads to the conclusion that the average projected scattering angle per collision is only about 6 degrees. A.

537.591.5

4676. Geomagnetic and albedo studies with a Čerenkov detector at 40° geomagnetic latitude. J. R. Winckler and K. Anderson. *Phys. Rev.*, **93**, 596–605 (*Feb.* 1, 1954).

A Cherenkov detector consisting of a Lucite radiator optically sealed to a large-area side-window photomultiplier has been flown at $\lambda = 40°$ at a depth of 25 g/cm² below the top of the atmosphere. The albedo was determined and is not more than 5% of the incident flux for particles of $\beta > 0{\cdot}7$ in any upward direction. The albedo observed is too small to account for the factor-of-two difference between the observed E–W asymmetry and that predicted from the primary spectrum and geomagnetic theory. Direct asymmetry measurements by the Cherenkov counter suggest that the earth shadow cone cut-off may start at larger zenith angles than theoretically predicted. A very rough relative abundance measurement of H : He : Li gives 1 : 0·08 : 0·02. A.

537.591.5 : 523.7

4677. Cosmic radiation in the trapped orbits of a solar magnetic dipole field. S. B. Treiman. *Phys. Rev.*, **93**, 544–50 (*Feb.* 1, 1954).

One of the well-known consequences which would follow from the existence of an appreciable solar magnetic dipole field is a diurnal variation in cosmic-ray intensity at intermediate latitudes on the earth. For the purpose of calculating the expected diurnal effect, it is first necessary to determine the extent to which the bounded orbits of the solar field are filled by the mechanism which has been discussed by Kane, Shanley and Wheeler: namely, the scattering of cosmic-ray particles into bounded orbits as a result of magnetic deflection in the earth's field. A calculation of this effect is carried out here along the lines indicated by Kane, Shanley, and Wheeler but with several modifications. A solar dipole moment of $6{\cdot}5 \times 10^{33}$ gauss. cm³, which is implied by the latitude cut-off at the earth, is adopted for the calculations. The cosmic-ray intensity in the trapped orbits is found to be appreciably smaller than indicated in the earlier calculations. Correspondingly, it is expected that diurnal effect at the earth will be larger than currently accepted theoretical values. The appa experimental absence of the effect, although conclusive, casts doubt on the existence of a s dipole field as large as $6{\cdot}5 \times 10^{33}$ gauss. cm³. present work also provides an estimate of the aver time which a cosmic-ray particle would spend in trapping region. The value 5000 years, previo given, is revised downward by an order of magnitu

537.591.5 : 52

4678. Solar magnetic moment and diurnal variat in cosmic-ray intensity. J. Firor, F. Jory and S. Treiman. *Phys. Rev.*, **93**, 551–3 (*Feb.* 1, 1954).

The expected diurnal variation in cosmic-r intensity at geomagnetic latitude 60° has been c culated assuming a solar magnetic dipole moment $6{\cdot}5 \times 10^{33}$ gauss. cm³. The calculation is based new estimates of the intensity of cosmic radiation the trapped orbits of the solar dipole field. T method of Dwight is followed, but with an importa modification. The magnitude of the expected diurn variation turns out to be about 12%.

537.59

4679. The transition effect for slow mesons. A. Vaisenberg. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 483–5 (1953) *In Russian.* English translation, *U. National Sci. Found. NSF-tr-93.*

A transition effect, due to the production of meso by the nucleon component of the cosmic-rays, h been observed by placing graphite over a counter s which detected the decay of slow μ-mesons. Max mum frequency of decays was observed for a thickne of ~ 20 g.cm^{-2}. H. Ellio

537.591

4680. The transition effect of star-producing radia tion. L. Tomášková. *Czech. J. Phys.*, **2**, 102–1 (1953).

Emulsion technique confirmed the transition effe of nuclear stars, i.e. the increase in their numbe under layers of a few cm of lead with the mai maximum exceeding by 15% under 2 cm of lead With disintegrations having an excitation energ $U > 200$ MeV a tendency to a second maximum wa observed under greater thicknesses of lead. Th character of the absorption of the individual track (due to "protons") was found similar to the absorptio curve of stars, the difference being that the maximum under 2 cm of lead is even by 34% above the exponen tial decrease. It is considered as most probable tha the main maximum of the stars having excitation energies $U < 200$ MeV is caused by the photon component of cosmic-rays while the anomalous increase in the number of disintegrations having energies $U > 200$ MeV is due to fast neutrons. It was not possible to estimate the contribution of mesons from the given experimental material. A.

537.591.8

4681. On a pair of close correlated stars. G. Lovera, L. B. Silva, C. Bonacini, C. De Pietri, R. P. Fedeli and A. Roveri. Letter in *Nuovo Cimento*, **10**, 986–7 (*July*, 1953) *In Italian.*

The stars were observed in a G5 plate exposed at a

ght of 22 km. The distance between their centres only 2 μ. The larger star is of type 13 + 1 *n*. The aller star has four prongs. The indications are at the smaller star is due to the retarded dis- egration of a heavy fragment. L. PINCHERLE

537.591.8

82. Cherenkov effect in vapours. A. ASCOLI LZANELLI AND R. ASCOLI. Letter in *Nuovo mento*, **10**, 1345–6 (*Sept.*, 1953) *In Italian.*

A preliminary experiment is described detecting e Cherenkov radiation produced by cosmic rays in mixture of air and chloroform. L. PINCHERLE

537.591.8

83. A *K*-meson resulting from a star. M. BALDO ND B. SECHI. Letter in *Nuovo Cimento*, **10**, 1482–4 *Oct.*, 1953) *In Italian.*

Observed in a G5 plate exposed at a height of 27 km. s emission energy was only 5·3 MeV. This may ean either that the meson had a negative charge, r that at the moment of the emission the nucleus as already practically destroyed, so that the concept f a potential barrier cannot be applied.

L. PINCHERLE

537.591.8

84. An unusual star. S. NAKAGAWA, H. HUZITA ND K. OKUDAIRA. Note in *J. Phys. Soc. Japan*, **8**, 01–2 (*Nov.–Dec.*, 1953).

Multiple scattering and energy balance measurements indicate a $1000m_e$ particle as primary of a -prong star. W. J. SWIATECKI

537.591.8

85. Nuclear interactions of secondary shower particles of cosmic rays in lead and carbon. I. KITA AND O. MINAKAWA. *J. Phys. Soc. Japan*, **9**, 6–13 *Jan.–Feb.*, 1954).

Nuclear events produced by secondary shower particles of cosmic rays have been observed in a cloud chamber operated at Mt. Norikura, at 2840 m altitude. In the chamber were mounted lead and carbon plates, and a comparison was made for penetrating showers originating in these two materials. The results show that the nuclear cross-sections for lead and carbon are in the ratio of geometrical values. The multiplicities of shower particles in lead are definitely larger than those in carbon, but the angular distributions show no differences in either case. These results can be interpreted quite naturally if it is considered that the shower particles inevitably contain high-energy protons besides mesons, and that the created meson or recoil proton which is emitted at large angle from the initial direction of the colliding particle has insufficient energy to produce energetic particles. A.

537.591.8

4686. Cosmic-ray nuclear interactions in gases. W. W. BROWN. *Phys. Rev.*, **93**, 528–34 (*Feb.* 1, 1954).

The natural rates of occurrence, in the gases He, N, Ne and A, of nuclear interactions of the cosmic-ray N component in which more than 8 MeV are given to charged secondary particles, were measured. The rates per gram atom of the four gases are in about the same ratio as their geometric nuclear cross-sections. An integrated flux of *N* rays of $6{\cdot}0\times 10^{-3}$ cm^{-2}. sec^{-1} would produce the observed rates of occurrence of nuclear interactions if the cross-section were geometric. The rates in argon, measured at sea level and 10 600 ft elevation, correspond to an absorption mean free path in air of 132 ± 4 g.cm^{-2} for the total flux of *N* rays. The interactions, 2783 in total, were observed in the gas of a cloud chamber filled to 5 atmos. pressure. Inside the cloud chamber was placed a system of wires forming an ionization chamber. An expansion was initiated whenever a pulse from the ionization chamber corresponding to an energy release of more than 8 MeV (1·5 Po alpha) occurred. Fast reduction of the high voltage after electron collection was over permitted track formation on the positive ions. Of the nuclear interactions produced in argon about 20% are produced by charged particles at the higher elevation and about 15% at sea level. A.

537.591.8

4687. Emulsion studies of cosmic-ray stars produced in metal foils. I. G. BARBOUR. *Phys. Rev.*, **93**, 535–43 (*Feb.* 1, 1954).

A method is described in which cosmic-ray induced disintegration of nuclei of several elements are studied with metal foils sandwiched between nuclear emulsions placed face-to-face and exposed at balloon altitudes. The range distributions of low-energy particles are obtained from tracks ending in the emulsion. Calculation of the probabilities of detecting star particles permits conversion of the observed star size distributions to the real size distributions, whose variation with atomic number is presented. The variation, with atomic weight, of the cross-sections for the production of stars of various sizes is analysed. The number of tracks per star corresponding to protons in the energy range 25–100 MeV is obtained and found to vary approximately as the nuclear radius. A.

537.591.8

4688. Neutron production by cosmic rays. W. C. G. ORTEL. *Phys. Rev.*, **93**, 561–7 (*Feb.* 1, 1954).

An experimental study has been made of the production of neutrons in the nuclear interactions of cosmic rays. An apparatus selected events in which a nuclear interaction occurred in or near a liquid scintillation counter, with the production not only of ionizing particles but also of neutrons of a few MeV energy which were slowed to thermal energy in a paraffin moderator and detected by BF_3-filled proportional counters. Such coincidences are termed (s, n), $(s, 2n)$, and so on, according to the number of detected neutrons. The average number, ν, of neutrons produced per disintegration was calculated from the observed relative numbers of (s, n) and $(s, 2n)$ coincidences. These data were obtained at Climax, Colorado, at an altitude of 11 200 ft. Analysis shows that events of the type selected in this experiment account for the production of 3×10^{-4} neutrons g^{-1} sec^{-1}, a figure which is close to the total neutron-production rate in carbon as previously measured at the same location. In these events, it is concluded that $\nu = 1{\cdot}3 \pm 0{\cdot}2$. Combination of this result with previously determined relative multiplicities yields the values $\nu = 2{\cdot}2$ for production in aluminium and $\nu = 6$ for production in lead. A.

537.591.8

4689. Study of charged *K*-mesons by means of two superposed Wilson chambers. B. Gregory, A. Lagarrigue, L. Leprince-Ringuet, F. Muller and C. Peyrou. *Nuovo Cimento*, **11**, 292–309 (*March*, 1954) *In French.*

Results were obtained with an experimental arrangement consisting essentially of two large cloud chambers placed one above the other. The top chamber had a magnetic field while the bottom chamber was of the multiplate type. The different sections of the paper can be summarized as follows: 1. The double cloud-chamber method is compared with other more conventional methods. 2. The apparatus is briefly described. 3. The behaviour in the multiplate chamber of the charged secondaries of $V^{\pm}$-decays occurring in the top chamber is discussed. π-mesons have been identified through their nuclear interactions. The presence of μ-mesons is also strongly suggested by: (*a*) the long mean-free-path of the secondaries and (*b*) one direct mass measurement. 4. *S* and slow $V^{\pm}$-events observed in the multiplate chamber are discussed. It is shown that one should distinguish between two groups of decays: One with secondaries of range smaller than 20 g.cm^{-2} of Pb, the other with larger range secondaries. Although the first group can be due to τ-mesons, the second group cannot be so explained, at least not phenomenologically. 5. The results of mass measurements—from range and momentum—on the primaries of the second group of events are presented. The measurements agree with a unique value of $(914 \pm 20)\ m_e$; which appears to be different from the τ-mass. 6. It is shown that some, and probably most, of the secondaries of this second group of events are μ-mesons. This conclusion is based on the dynamics of the decay and results from the measured mass of the primary particle and the observed ranges of the secondaries. The observation of one large angle scattering indicates, however, that π-mesons may also be present among the secondaries. 7. The data on the range of the charged secondaries are analysed. Excluding the possible π^- secondary, results are in good agreement with a μ-meson of unique momentum. However, a continuous spectrum, sharply peaked in the high momentum region, is not excluded. 8. The almost complete absence of negative primaries for *S*-events is reported. 9. The results are compared with those obtained elsewhere. They agree with other cloud-chamber results assuming the existence of π-secondaries with a range of 66 g.cm^{-2} of Pb. The spectrum obtained for the μ-secondaries does not fit with that of the secondaries of κ-particles found in photographic emulsions. 10. The conclusions are summarized. A.

537.591.8 : 539.18

Preliminary research on V_1^0 events in emulsions. *See Abstr.* 3883

MAGNETISM 538

538.1 : 530.12

Rotation and magnetism in the world-models of kinematic relativity. *See Abstr.* 4154

538.1

4690. A contribution to the problem of the extens of Heisenberg's theory of ferromagnetism to ma electron atoms. L. Valenta. *Czech. J. Phys.*, 36–49 (1952) *In Russian*; *Summary* (*800 words*) *English.*

Gives a theoretical discussion, on standard lin extending Heisenberg's treatment. The secu equation can only be solved after making certa simplifying assumptions. The magnetic moment expressed as a function of the total spin compone and the number of electrons per atom.

E. P. WOHLFAR

538.1

4691. The magnetic properties of a linear atom chain at absolute zero and with a positive exchan integral. E. Ledinegg and P. Urban. *Acta ph Austriaca*, **8**, *No.* 2, 167–74 (1953) *In German.*

It is shown by an application of a modified sp wave treatment, using a method due to Hulthèn, th the linear chain cannot be ferromagnetic at 0 and $J > 0$.

E. P. WOHLFAR

538.1

4692. Antiferromagnetism. The kagomé Ising n K. Kanô and S. Naya. *Progr. theor. Phys.*, **1** 158–72 (*Aug.*, 1953).

The eigenvalue problem of the kagomé Ising n with $z = 4$ can be solved exactly. The transitio temperature lies a little below that of the squa lattice. Its value is determined by $e^{4J_c} = 3 + 2\sqrt{}$ and it may be concluded that it is not determine only by the number of nearest neighbours. In th case of antiferromagnetism, especially, the kagon lattice which does not fit an antiferromagnet arrangement is disordered at all temperatures an possesses a finite zero-point entropy just as in th case of the triangular lattice. The resulting expre sion is:

$$\frac{S_k(0)}{R} = \frac{1}{24\pi^2}\int_0^{2\pi}\int_0^{2\pi} \log\{21 - 4\,[\cos\omega_1 + \cos\omega_2 + \cos(\omega_1 + \omega_2)]\}d\omega_1 \,.\, d\omega_2 \simeq 0{\cdot}50183.$$

A

538.11

4693. Surface anisotropy of ferromagnetic sub stances. L. Néel. *C.R. Acad. Sci.* [*Paris*] **237** 1468–70 (*Dec.* 9, 1953) *In French.*

The new effect arises as a result of a term of th form $LP_2(\cos\phi)$ in the magnetocrystalline an magneto-elastic energy expression for a ferromagneti substance, where ϕ is the angle between the direction of magnetization and the line joining two atoms in the crystal, and where L is supposed to be of spin-orbi coupling origin and a short range function of the inter atomic separation. The function L may be expressed in terms of the magnetostriction and elastic coeffi cients. Since dipole-like terms involving P_2 do no average to zero over the surface of the body, a surface anisotropy effect results, which may be of the same order as the shape anisotropy effect of small ferro magnetic particles if their smallest linear dimension is less than a critical value, roughly estimated to be about 60 Å.

E. P. WOHLFARTH

538.114

4. Superlattice formation by orientation. L. EL. *C.R. Acad. Sci.* [*Paris*] **237,** 1613–16 (*Dec.* 21, 3) *In French.*

An application of the idea of surface anisotropy preceding abstract) to the formation of uniaxial ter in binary ferromagnetic alloys by means of a gnetic annealing treatment. Application is made Permalloy [Abstr. 8530 (1953)] and other alloys.

E. P. WOHLFARTH

538.114

95. Superlattice formation by orientation due to chanical deformations. L. NÉEL. *C.R. Acad. Sci. ris*] **238,** 305–8 (*Jan.* 18, 1954) *In French.*

Shows by an extension of earlier work [preceding stract] that a magnetic anisotropy of appreciable gnitude may be produced in a binary alloy by e application of an external stress at high tem- ratures and that an ordering process may be duced thereby. Application is made to Fe–Ni oys [Rathenau and Snoek, *Physica,* **8,** 555 (1941)].

E. P. WOHLFARTH

538.114

96. Effect of particle shape variations on the ercive force of ferromagnetic micro-powders. E. P. OHLFARTH. *Research* Correspondence, **7,** S 1–S 20 *March*, 1954).

Gives a general discussion applicable to assemblies single domain powders, the interparticle interaction ing assumed negligible or having been allowed for. number of different forms of the shape distribution nction is considered, with reference to previous eoretical work [Néel, Abstr. 3260 (1947)] and with plicability to experimental results obtained with arious types of micro-powders [Weil, Abstr. 7066 951); Meiklejohn, Abstr. 8543 (1953)].

E. P. WOHLFARTH

538.114 : 586.631

The heat capacity of gadolinium from 15 to 355°K. *ee Abstr.* 4478

538.12 : 621.318.3

697. A very powerful electromagnet for nuclear lates. G. SOMEDA. *Nuovo Cimento,* **11,** 73–81 (*Jan.*, 954) *In Italian.*

An electromagnet has been designed and constructed or producing sufficiently high fields to enable direct nd systematic measurements to be made of particles n nuclear emulsions. For a power consumption of 00 kW, a field of 50 000 gauss has been attained in he disk-shaped volume between the pole pieces 3 cm n depth and 10 cm in diameter. A.

538.22

4698. Magnetic susceptibilities of Np^{+6}, Np^{+5}, and Np^{+4}. D. M. GRUEN AND C. A. HUTCHISON, JR. *J. chem. Phys.*, **22,** 386–93 (*March*, 1954).

The magnetic susceptibilities of $NaNpO_2(CH_3COO)_2$, $NpO_2C_2O_4H.H_2O$ and $KNpF_5$ have been measured from 14°K to 320°K. The magnetic susceptibilities of the ions Np^{+6}, Np^{+5} and Np^{+4} have been compared with those calculated for ions in electronic states of f-electron configurations in the presence of electric fields of specific forms and with various amounts of spin-orbit coupling. A.

538.22 : 536.631

Thermal anomalies associated with the antiferromagnetic ordering of FeF_2, CoF_2 and NiF_2. *See Abstr.* 4479

538.22 : 541.67

4699. General principles of magnetochemistry; their applications to the study of structures. A. PACAULT. *Experientia,* **10,** *No.* 2, 41–59 (1954) *In French.*

Magnetic units of isotropic substances are defined, and the main apparatus for measuring magnetic susceptibilities is indicated. The notion of a magneto-chemical system is developed and its use in the study of molecular structure is shown. Finally, the author shows how magnetochemistry has been used to study the electronic delocalization in aromatic molecules, and the concomitance existing between this delocalization and the biological properties of certain substances, such as their mitotic and carcinogenic activities. A.

538.221

4700. On an amplitude- and temperature-dependent after-effect in α-iron at −70°C. G. SORGER. *Z. angew. Phys.*, **5,** *No.* 11, 406–13 (1953) *In German.*

Complex permeability measurements on Fe and Fe–Si alloys indicate the existence, around −70°C, of a new type of after-effect. This after-effect decreases as the applied field increases and is associated with an activation energy of 0·3 eV/atom. The effect was not found with an Fe–Ni alloy with γ-structure. A formal theory explaining the effect is developed which indicates a relationship between the after-effect and the variation of permeability with field strength.

A. E. DE BARR

538.221

4701. A tentative interpretation of Bickford's observation of the resonance absorption in magnetite below its transition point. T. NAGAMIYA. *Progr. theor. Phys.*, **10,** 72–82 (*July*, 1953).

An interpretation is given of the double peak resonance absorption observed by Bickford [Abstr. 8533 (1953)] in magnetite below its transition point −160°C. An anisotropy energy of tetragonal symmetry is assumed as in his case, and for weaker fields a magnetic structure of parallel flat domains is assumed. When the magnetization vectors on both sides of each wall oscillate in a certain manner, a surface magnetic charge will be produced on the wall and this in turn will produce an oscillating magnetic field in each domain. The frequency of oscillation is thus increased. A.

538.221

4702. Magnetic losses in a rotating field; the fluctuation mechanism of magnetic viscosity. J.-C. BARBIER. *J. Phys. Radium,* **14,** 61 S–62 S (*Dec.*, 1953) *In French.*

Describes measurements on an Alnico material under the influence of a slowly rotating weak magnetic field of strength H. The total loss W is given by $W/H^2 = A + BH$, and an application of Néel's theory [Abstr. 4211 (1950)] shows that the first term represents the loss due to magnetic viscosity, the second being the hysteresis loss. The value of the characteristic viscosity parameter S_V may be deduced from the constant A and is found to be in agreement with independent static measurements.

E. P. WOHLFARTH

538.221

4703. Antiferromagnetism. A. B. Lidiard. *Rep. Progr. Phys.*, **17**, 201–42 (1954).

The familiar Heisenberg theory of ferromagnetism in the 3*d* transition metals iron, cobalt and nickel, rests on the assumption of a positive exchange integral between neighbouring ions, since ferromagnetism is not possible in cases where this integral is negative ("antiferromagnetic"). The idea that the remaining non-ferromagnetic members of the 3*d* series (Sc, Ti, V, Cr, Mn) therefore have negative exchange integrals led to a theoretical study of the properties of antiferromagnetic systems. Néel was the first to show that such a system has a critical temperature, T_c, below which the atomic moments are arranged alternately parallel and antiparallel. Above T_c the moments are disordered, as in a ferromagnetic above its Curie temperature. The theory was later extended by Van Vleck and it then became apparent that the antiferromagnetic model closely fitted a number of simple compounds of the transition metals (e.g. CrSb, MnO, MnF_2). These early developments are described. Particular attention is given to Van Vleck's theory, as this forms a starting point for much subsequent work. Later experimental studies of antiferromagnetic compounds are reviewed, especial attention being paid to the results obtained by the methods of neutron diffraction. Measurements of magnetic anisotropy and of the slight distortions which occur in many antiferromagnetic lattices on ordering, are also described in detail, and the theoretical significance of the observations is discussed incidentally. The theoretical attempts to improve the Van Vleck theory, both by extending the model and by using more accurate statistics, are considered. This section also includes a discussion of the superexchange mechanism, which accounts for the observation that the strongest interactions in, say, MnO are between next nearest neighbouring Mn ions and not between nearest neighbours as one might expect. The final section contains a brief survey of the present status of the non-ferromagnetic transition metals themselves; it is shown how the recent neutron diffraction studies by Shull and Wilkinson favour a collective electron description, rather than the sort of description which is successful for the antiferromagnetic compounds. The way to extend the present collective electron theory so that it may give antiferromagnetic ordering has recently been indicated by Slater. There is a table listing experimental papers on antiferromagnetism by compound and by the property studied. This should be useful since it is often difficult to trace the experimental work on a particular compound of interest. There is also a bibliography of 136 references. A.

538.221

4704. The threshold field phenomenon in an antiferromagnetic single crystal. N. J. Poulis and G. E. G. Hardeman. *Physica*, **20**, 7–12 (*Jan.*, 1954).

The threshold field in an antiferromagnetic single crystal of $CuCl_2.2H_2O$ was measured as a function of the temperature. A change in character of the proton magnetic resonance of $CuCl_2.2H_2O$ was used as a criterion for the threshold field phenomenon. The proton resonance in paraffin wax surrounding the crystal indicated the field strength. The measurem were carried out in a temperature range of 4·30° 1·25°K. The theoretical relation between the thres field and the spontaneous magnetization allows temperature dependence of the difference betwee principal susceptibilities, $\chi_\perp - \chi_{||}$, to be predic

538

4705. Magnetic properties of titanium sesquiox S. F. Adler and P. W. Selwood. *J. Amer. Ch Soc.*, **76**, 346–7 (*Jan.* 20, 1954).

Magnetic susceptibility measurements over a ra of temperature have been made on pure Ti sesquiox on the sesquioxide supported on γ-alumina and solid solutions of Ti_2O_3 and Al_2O_3. The p sesquioxide is antiferromagnetic with a Curie po near 248°K. In supported and dissolved forms tripositive Ti ion shows increasing susceptibility w increasing magnetic dilution. At infinite dilution magnetic moment is approximately that expected one unpaired electron spin. Some phases sho slight ferromagnetism.

538.2

4706. Magnetic resonance phenomena in ferrit F. Brown and D. Park. *Phys. Rev.*, **93**, 38 (*Feb.* 1, 1954).

The resonant frequencies of the rotations of dom magnetization in ferrimagnetic materials are calcula by the use of the molecular field approximation, tak into account the effects of anisotropy, external fie and differences in magnetization and *g* values betwe the two sublattices. Resonance is found to occur two frequency bands: one in a microwave band, whi various workers have investigated experimentally, a one in the infrared, predicted earlier by Kaplan a Kittel. It is necessary to discuss critically the physic nature of the anisotropy field entering the equation when this is done, an excellent agreement is found wi the measurements of Yager *et al.* and Healy on sing crystals of nickel ferrite. Finally, the relation betwe the theory presented here and experiments on sintere samples of ferrite is discussed.

538.22

4707. The change of ferromagnetic Curie points wi hydrostatic pressure. L. Patrick. *Phys. Rev.*, 9 384–91 (*Feb.* 1, 1954).

The effect of pressure on the Curie temperature wa measured for 13 ferromagnetic materials, comprisin 4 elements (Fe, Co, Ni, Gd), 7 metallic alloys, a ferri and a perovskite. Curie points ranged from 16°c (Gd to 1120°c (Co), and pressures up to 9000 atmos. Th results are in disagreement with two common form of the interaction curve. The result obtained for Fe i not in agreement with the prediction of Kornetzk based on volume magnetostriction measurement between 20°c and 100°c. A

538.22

4708. The influence of pressure on the Curie tem perature of iron and nickel. R. Smoluchowski *Phys. Rev.*, **93**, 392–3 (*Feb.* 1, 1954).

A comparison is made between Patrick's measure ments of the change of Curie temperature under pres sure and theory based on a Brillouin function. The agreement is fair. A.

538.221

9. Magnetic resonance in αFe_2O_3. P. W. DERSON, F. R. MERRITT, J. P. REMEIKA AND W. A. GER. *Phys. Rev.*, **93**, 717–18 (*Feb.* 15, 1954).

Magnetic resonance experiments performed on e_2O_3 confirm the existence of a highly anisotropic, ak ferromagnetism which disappears below −15°C. e anisotropy energy has been studied as a function orientation. A.

538.221 : 537.311.33 : 536.631

Susceptibility of nickel oxides. *See Abstr.* 4477

538.221 : 548.7

10. Contribution to the extension of knowledge of mentary magnetization processes in iron-silicon ystals. B. ELSCHNER. *Ann. Phys.* [*Leipzig*] **13**, . 6–8, 290–304 (1953) *In German.*

Reports results of powder pattern experiments. bservations were carried out on domains in the ighbourhood of crystal grain boundaries and near tural and artificial surface imperfections. By plication of an external magnetic field the movement 180° domain boundaries past such imperfections as studied. The effects of temperature changes on undary movement was also studied. Numerous otographs of a high quality are reproduced.

E. P. WOHLFARTH

538.221 : 548.7

11. Magnetic behaviour of thin single-crystal ckel films. L. E. COLLINS AND O. S. HEAVENS. *hil. Mag.*, **48**, 283–90 (*March*, 1954).

The coercivity of monocrystalline films of nickel, own epitaxially on the (100) face of rocksalt, was udied as a function of thickness over the range 00 Å to 1000 Å. Films grown in this way do not hibit the granularity characteristic of films deposited n cold, inactive substrates; electron micrographs how continuity over distances of the order several icrons. The behaviour of such a film is expected be simpler than that of a polycrystalline film, in hich the magnetic properties depend on crystallite oundaries, crystallite size distribution, orientation, tc. Spontaneous magnetization of the films is bserved, with the magnetization vector in the plane f the film. The high coercivity characteristic of a ingle domain structure is observed and the maximum alue agrees roughly with that calculated from the nisotropy constants. As is expected, the behaviour f monocrystalline films differs markedly from that f polycrystalline specimens. A.

538.221 : 621.317.41.029.6

12. Measurement of ferromagnetic permeability t microwave frequencies. G. S. SANYAL AND J. S. HATTERJEE. *Indian J. Phys.*, **27**, 326–39 (*June*, 953).

The relative apparent permeabilities of soft iron nd nickel (in the form of thick plates) were measured t a free-space wavelength of 3·2 cm. The method f measurement, which employs a resonant cylindrical avity, is described. Expressions are derived relating he permeability, μ_R with the cavity parameters and he resonant frequency. Approximate relations, rom which μ_R can be easily calculated, are given. The method gives value of μ_R accurate within a few per cent. The effect of machining inaccuracy of one of the end walls of the cavity on the measurement of r.f. permeability is also discussed. A.

538.221 : 621.318.134

4713. Ferrites for microwave circuits and digital computers. E. ALBERS-SCHOENBERG. *J. appl. Phys.*, **25**, 152–4 (*Feb.*, 1954).

Ferrites of the system MgO–MnO–Fe_2O_3 have been investigated, and two new classes of magnetic materials have been developed. One class of ferrite has low losses and shows the Faraday rotation effect at microwave frequencies, which makes it useful in new types of microwave components. A second class of ferrite has a rectangular hystersis loop and inherent high resistivity which allows digital computer magnetic memories to be operated at much greater speeds than was possible with the familiar magnetic metal alloys. Both classes of ferrites are now commerically available. A.

538.221 : 621.318.134

4714. Ferromagnetic spinels with rectangular hysteresis loops. I. J. HEGYI. *J. appl. Phys.*, **25**, 176–8 (*Feb.*, 1954).

The ferromagnetic spinel $MgO.3MnFe_2O_4$, "magnesium manganese ferrite" is satisfactory for magnetic memory devices. Small rings of about 55 mil diameter which have proved practical for memory matrix use have a coercive force of about 3 oersteds and switch-over time of 0·3 microsecond, and a nearly rectangular hysteresis loop. Rings of about 0·5 cm diameter which were used to study composition variables showed a lower coercive force of 1·6 oersteds for the same composition and processing. Resistivities are in the order of 45×10^3 ohm cm. A.

538.222

4715. Magnetic properties of titanium hydrides. W. TRZEBIATOWSKI AND B. STALIŃSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 131–5 (1953).

The magnetic susceptibilities of the titanium-hydrogen system throughout the range Ti to $TiH_{1.98}$ and of three titanium deuterides were determined at temperatures 80°–470°K using a Gouy balance. The paramagnetism generally increases with hydrogen content but minima are observed in the susceptibility isotherm at $TiH_{1.2}$ and $TiH_{1.9}$ and a maximum at $TiH_{1.8}$. These may be attributed to the decoupling of *d*-shells and the increase in total number of electrons. At compositions exceeding $TiH_{1.70}$ a distinct maximum is observed on the χ-temperature curves at about 300°K, and this is taken as a proof of antiferromagnetism. G. I. W. LLEWELYN

538.222

4716. Paramagnetic resonance in nickel sulphate heptahydrate. K. ŌNO. Note in *J. Phys. Soc. Japan*, **8**, 802–3 (*Nov.–Dec.*, 1953).

Reports results of measurements on $NiSO_4.7H_2O$ in fields up to $2·5 \times 10^4$ oersted. Resonance absorption lines were observed at wavelengths 0·54 and 0·65 cm, the line width being about $1·5 \times 10^3$ oersted. Values of the parameters in the Hamiltonian are deduced, the *g* value being 2·20. The magnetic anisotropy was also investigated. E. P. WOHLFARTH

538.222

4717. Paramagnetic susceptibility measurements on AgMn and AuMn alloys. F. KRONQVIST AND A. GIANSOLDATI. *Ark. Fys.*, **7**, *Paper* 26, 343–51 (1953).

The temperature dependence of the magnetic susceptibility has been determined for these alloys. The results from these and previous measurements show that the average atomic moment of the Mn atom decreases approximately linearly, when the concentration of Mn increases in the alloys. The extrapolated moment for infinite dilution is about 6 Bohr magnetons, corresponding to $S \simeq 5/2$. The influence of cold-working on the paramagnetic susceptibility was fairly large; only the interaction energy changed, however, and the average atomic moment of the Mn atoms was not affected. A.

538.222

4718. Anomalous paramagnetic resonance in copper propionate. H. ABE. Letter in *Phys. Rev.*, **92**, 1572 (*Dec.* 15, 1953).

$Cu(CH_3CH_2COO)_2.H_2O$ resembles the acetate in having pairs of Cu ions strongly coupled to give an equivalent spin $S = 1$. The detailed parameters are given and there are 6 non-equivalent pairs per unit cell. The formate shows no such anomaly.

D. H. WHIFFEN

538.222

4719. Spin-lattice relaxation and the residual width of highly exchange-narrowed paramagnetic resonances. J. P. LLOYD AND G. E. PAKE. Letter in *Phys. Rev.*, **92**, 1576 (*Dec.* 15, 1953).

The exchange-narrowed line width at 60 Mc/s for the paramagnetic resonance is entirely due to the spin-lattice relaxation time of $6{\cdot}3\times10^{-8}$ sec for diphenyl picryl hydrazyl and $1{\cdot}6\times10^{-7}$ sec for tris-*p*-nitrophenyl methyl, since these values account satisfactorily for the line width and the power saturation. The zero r.f. field width 0·97 Oe for the hydrazyl is less than the value 1·35 Oe obtained at 9000 Mc/s; this difference is in the opposite direction to van Vleck's prediction [*Phys. Rev.*, **57**, 426–47 (*March* 1, 1940)].

D. H. WHIFFEN

538.222

4720. Experimental techniques used for studying paramagnetic relaxation and electron paramagnetic resonance. J. COMBRISSON AND J. UEBERSFELD. *J. Phys. Radium*, **14**, 724–30 (*Dec.*, 1953) *In French.*

An extension of the review reported in Abstr. 5571 (1953), to which there are errata on p. 730.

D. H. WHIFFEN

538.222

4721. On the magnetic properties of cobaltic, ferric and chromic ions in coordination. N. PERAKIS, J. WUCHER AND T. KARANTASSIS. *C.R. Acad. Sci.* [*Paris*] **238**, 475–7 (*Jan.* 25, 1954) *In French.*

Reports susceptibility measurements on the salts $K_3M(C_2O_4)_3.3H_2O$ between 16° and 290°K, where M = Co, Fe, Cr. The Curie temperatures and effective magneton numbers of the M ions are deduced. There is a difference in behaviour between the Cr, Fe salts and the Co salt; this is discussed in relation to the electronic configuration. E. P. WOHLFARTH

538

4722. On the hyperfine structure of the paramag resonance in some phosphorescent substances. UEBERSFELD. Letter in *J. Phys. Radium*, **15**, 1 (*Feb.*, 1954) *In French.*

Using a cavity resonator in the TE_{011} mode an axial sample, the six hyperfine peaks of Mn^{++} ZnS phosphor are clear at less than 5×10^{-5} Mn per g. D. H. WHI

538

4723. Detection of paramagnetic resonance irradiated glass. J. COMBRISSON AND J. UEBERSF *C.R. Acad. Sci.* [*Paris*] **238**, 572–3 (*Feb.* 1, 1954 *French.*

Describes experiments, using the apparatus scribed previously (preceding abstract) on g specimens which had been discoloured by previ irradiation with thermal neutrons or γ-rays, releasing paramagnetic impurities. Heating specimens at 150°C caused the impurities to re-dissolved. E. P. WOHLFA

538.

4724. Paramagnetic resonance absorption of Mn in single crystals of $CaCO_3$. F. K. HURD, M. SA AND W. D. HERSHBERGER. *Phys. Rev.*, **93**, 373 (*Feb.* 1, 1954).

Paramagnetic resonance absorption of Mn^{++} 9300 Mc/s was studied using single crystals of CaC containing 0·06 wt. % Mn^{++} ions. The Mn spectrum consists of 30 well-resolved lines appro mately 3·5 gauss wide and extending over a range 1100 gauss with a large dependence upon angu orientation between crystal axes and external mr netic field. The theory pertaining to the Mn resonance absorption in the $CaCO_3$ crystal developed and presented. The interpretation of observed spectra is based upon crystalline field effe plus nuclear hyperfine interaction. The spectrosco g factor is found to be essentially isotropic. T hyperfine structure factors A' and B' are found to nearly equal. The fine structure constants D' a d' are determined. The values assigned a $g_{\|} = 2{\cdot}0022$, $g_{\perp} = 2{\cdot}0014$, $A' = 8{\cdot}782\times10^{-3}$ cm $D' = 3{\cdot}75\times10^{-3}$ cm^{-1}, $d' = 4{\cdot}00\times10^{-6}$ cm^{-1}, B' $8{\cdot}774\times10^{-3}$ cm^{-1}. Small discrepancies betwe theory and experiment are found, as well as unc pected and unexplained line-splittings at certa angular orientations.

538.2

4725. Paramagnetic resonance absorption of carba and hydrazyl. C. KIKUCHI AND V. W. COHEN. *Phy Rev.*, **93**, 394–9 (*Feb.* 1, 1954).

The paramagnetic resonance spectra of sing crystals of carbazyl and hydrazyl show distin anisotropies, which appear to be associated wi the microscopic magnetic susceptibility within t molecule in the vicinity of the unpaired electro This leads to an asymmetry in the absorption li of a polycrystalline specimen. The hyperfine stru tures of the two radicals in a benzene solution sho that in carbazyl the two N atoms are non-equivale in that the odd electron spends approximately twi as long in the vicinity of one, compared to the othe

538.222

5. Microwave resonance absorption in nickel ite-aluminate. T. R. McGuire. *Phys. Rev.*, **93**, -6 (*Feb.* 15, 1954).

agnetic resonance measurements on $NiOAl_tFe_{2-t}O_3$ g values which shifted from $g > 2$ to $g < 2$ pproximately $t = 0{\cdot}7$. At this composition the inant magnetic moment changes from the *B* to the ites and the shift in *g* values is believed to be related with the vanishing of the magnetic moment angular momentum at different points close to $0{\cdot}7$. The *g* values have the general characteristic decreasing in magnitude as the temperature is ed. At $t = 1{\cdot}75$ and $-196°$C two resonant peaks e observed, one with $g = 1{\cdot}4$ and a new peak h $g = 4{\cdot}0$, while for $t = 2$ (nickel aluminate) no onance absorption was observed. The half-widths he resonance curves increased to a maximum value $t = 0{\cdot}5$ and went through a minimum in the ion of $t = 1{\cdot}25$. A.

538.222

27. The paramagnetic resonance spectra of olinium and neodymium ethyl sulphates. B. EANEY, H. E. D. Scovil and R. S. Trenam. *Proc. y. Soc. A*, **223**, 15–29 (*April* 7, 1954).

Accurate measurements of the paramagnetic onance spectra of gadolinium and neodymium yl sulphates have been made both in strong agnetic fields at a wavelength of 3 cm, and in weak lds at wavelengths between 6 and 22 cm. (i) the Gd^{3+} ion is in an ^8S state, whose levels are split the action of the crystalline electric field, which is sumed to have C_{3h} symmetry. The results are nsistent with this supposition, except for some screpancies in the position of the zero field lines, ose origin is not certain. The main parameters in e spin Hamiltonian are evaluated, and the spectro-pic splitting factor is found to be isotropic at $.990 \pm 0{\cdot}002$. (ii) The Nd^{3+} ion is in a $^4I_{\frac{9}{2}}$ state, ich is split by the crystal field leaving a Kramers ublet as the ground state. The hyperfine structure ue to the two odd isotopes 143, 145 has been easured and gives the ratio of the nuclear magnetic oments (143/145) as $1{\cdot}6083 \pm 0{\cdot}0012$. Some all discrepancies in the positions of the hyperfine ies in zero field are found, which prevent the deter-ination of accurate values of the nuclear electric adrupole interaction. The theory of Elliott and evens [Abstr. 7797 (1953)] leads to values of $1{\cdot}0$ d $0{\cdot}62$ nuclear magnetons for the moments of otopes 143 and 145 respectively, with an uncertainty about $\pm 25\%$ arising from lack of a precise value r $\overline{r^{-3}}$, where *r* is the electron-nuclear distance. A.

538.222 : 539.152.2

728. Paramagnetic resonance spectra of some rric alums, and the nuclear magnetic moment of ^{57}Fe. . Bleaney and R. S. Trenam. *Proc. Roy. Soc. A*, **23**, 1–14 (*April* 7, 1954).

The paramagnetic resonance spectra of ferric ubidium sulphate and ferric potassium selenate ums (diluted with the corresponding aluminium ums) have been analysed in detail. It is found at the splitting of the ^6S state of the ferric ion can e explained in terms of a spin Hamiltonian containing trigonal terms of the second and fourth degree, and a cubic term. The measurements show also that the axes of the cubic crystalline field are rotated through a small angle from those of the crystal unit cell as expected from X-ray analysis of the structure [Lipson (1935)]. No hyperfine structure due to Fe^{57} could be resolved in a sample containing 40% abundance of this isotope. From analysis of the line shape, an upper limit of $0{\cdot}0006$ cm^{-1} could be placed on the overall width of any such structure, corresponding to a nuclear moment of $0{\cdot}05$ n.m. A.

538.222 : 539.152.2

The principle of nuclear induction. *See Abstr.* 4848

538.222 : 539.152.2

Research in nuclear magnetism. *See Abstr.* 4849

538.222 : 539.152.2 : 621.373.42

4729. A new modification of the method for determining nuclear induction. L. Pekárek and J. Urbanec. *Czech. J. Phys.*, **1**, *No.* 2, 78–9 (1952).

Figures show the performance of a type of push-pull oscillator circuit suitable for nuclear induction measurements at 30, 16, 5 and 1 Mc/s. D. H. Whiffen

538.222 : 539.153

4730. Magnetic resonance on optically oriented atoms. J. Brossel, B. Cagnac and A. Kastler. *J. Phys. Radium*, **15**, 6–8 (*Jan.*, 1954) *In French.*

A beam of Na atoms is first oriented by illumination with circularly polarized light in the presence of a magnetic field [Abstr. 5662 (1953)], then partly depolarized by magnetic resonance. The remaining polarization (as revealed by photomultiplier analysis of the re-emitted radiation) when plotted against the magnetic field for various radiofrequency powers reveals many details of transitions between Zeeman sub-levels of the $3^2S_{\frac{1}{2}}$ ground state. W. J. Swiatecki

538.222 : 621.317.4.029.6

4731. Instrumentation of microwave electron resonance in magnetic fields. R. C. Mackey and W. D. Hershberger. *Trans Inst. Radio Engrs, Prof. Group on Microwave Theory and Tech.*, **MTT–1**, 3–10 (*Nov.*, 1953).

An account of a paramagnetic resonance spectrometer employing a sample in a TE_{011} cylindrical resonator at 9300 Mc/s. The derivative of the absorption is displayed on a recorder together with magnetic field markers obtained from the frequency of a proton resonance system in the same field.

D. H. Whiffen

538.224

4732. On the magnetic susceptibility of several carbon blacks. A. Marchand. *C.R. Acad. Sci.* [*Paris*] **238**, 460–2 (*Jan.* 25, 1954) *In French.*

Reports room temperature susceptibility measurements. The mean diamagnetic susceptibilities are related to the diameters of the graphite planes, which were obtained by X-ray measurement.

E. P. Wohlfarth

538.244

4733. On a nonlinear diffusion equation applied to the magnetization of saturable reactors. S.-H. Chow. *J. appl. Phys.*, **25**, 377–81 (*March*, 1954).

The penetration of the magnetic field intensity into

the interior of an infinite slab of ferromagnetic material having a non-linear $B - H$ relationship is governed by a non-linear diffusion equation. For finite thickness of the slab, the problem is solved by an approximate method. A rigorous solution of the same problem when the thickness of the slab approaches infinity is given to justify the approximate method used. One term only is used to represent an infinite series in order to give a readily calculable result in "switching time." The result is then compared with that of the graphical solution of the same problem. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

4734. Electromagnetism without magnetism: an historical sketch. P. MOON AND D. E. SPENCER. *Amer. J. Phys.*, **22**, 120–4 (*March*, 1954).

Maxwell's formulation of electromagnetism is not the only formulation, though it is the most familiar. In particular, the whole subject of electrodynamics can be expressed as an extension of Coulomb's equation, with the magnetic field entirely eliminated. The paper reviews the history of this attack, beginning with the work of Coulomb, Ampère and Gauss, and concluding with recent developments. A.

538.3 : 537.12

4735. On the equation of motion of the electron in classical electrodynamics. P. CALDIROLA. Letter in *Nuovo Cimento*, **10**, 1747–52 (*Dec.*, 1953) *In Italian.*

A generalized equation of motion is obtained, based on the requirement that the laws of motion must be relativistically invariant. Some special cases considered are (i) a free particle, (ii) a particle subjected to a constant, or time-dependent force, (iii) a particle in a constant magnetic field. For related work by Dirac, see *Proc. Roy. Soc. A*, **167**, 148–69 (*Aug.* 5, 1938), and by Eliezer, see *Proc. Camb. Phil. Soc.*, **39**, 173–9 (*Oct.*, 1943). L. S. GODDARD

538.3 : 537.12

4736. Classical explanation of the anomalous magnetic moment of the electron. P. CALDIROLA. Letter in *Nuovo Cimento*, **11**, 108–10 (*Jan.*, 1954) *In Italian.*

The relativistically invariant classical equation for the radiating electron previously suggested by the author (preceding abstract) has periodic solutions which correspond to a rotation of the electron along a circle of radius $\beta R/\pi$, where R is the classical radius of the electron. The magnetic moment produced by this rotation coincides with the experimental anomalous magnetic moment if one takes $\beta^2 = 3/4$. The kinetic energy of the rotation is m_0c^2. L. PINCHERLE

538.32 : 621.3.011

4737. The principles of action and reaction and the laws of electrodynamics. M. GALLI. *Acta Pontif. Acad. Sci.*, **13**, *No.* 15, 201–12 (1949) *In Italian.*

A discussion of the old question of the validity of the laws for the interaction of two circuit elements. Quite apart from the possibility of giving a physical meaning to the analysis of a circuit in infinitesimal elements, it is shown that it is also impossible discriminate among the different (e.g. the Ampère the Biot–Savart) forms attributed to the elemen interaction, on the basis of general principles suc the law of action and reaction. L. PINCHE

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.

4738. On the tensor of conductivity [σ] of electr plasmas in the presence of a constant magnetic fi M. BAYET, J.-L. DELCROIX and J.-F. DENISSE. *Acad. Sci.* [*Paris*] **237**, 1503–5 (*Dec.* 9, 1953) *In Fren*

Jancel and Kahan's [Abstr. 1483 (1954)] express for σ differs from that of other authors. The ference, which is shown to be due to the neglect certain magneto-resistance terms by Jancel Kahan, no longer exists if these terms are inclu by using a higher degree of approximation.

J. DUTT

538.

4739. The excitation of plasma oscillations. D. LOONEY AND S. C. BROWN. *Phys. Rev.*, **93**, 96 (*March* 1, 1954).

A beam of high-energy electrons, injected into t plasma of a d.c. discharge from an auxiliary electr gun, excited oscillations in the plasma at the plas electron oscillation frequency given by the Tonk Langmuir equation. A movable probe showed t existence of standing-wave patterns of the oscillat energy in the region of the plasma in and arou the electron beam. Nodes of the patterns coincid with the electrodes which limited the region of t plasma traversed by the beam. The standing-wa patterns were independent of the frequency of t oscillation. At any particular frequency, the standi wave was determined by the thickness of the i sheaths on the bounding electrodes. The mechanis of the energy transfer from the electron beam to t oscillation of the plasma electrons was established a velocity-modulation process by the detailed b haviour of the frequency of oscillation and t transitions in the standing-wave patterns as the shea thickness was varied. Experimental attempts produce plasma oscillations as predicted by Bohm an Gross proved to be fruitless.

538.561 : 537.

4740. On the excitation of oscillations in a therm plasma. M. SUMI. *J. Phys. Soc. Japan*, **9**, 88–9 (*Jan.–Feb.*, 1954).

Plasma oscillations are considered for an arbitra distribution of electron beams. Under the assumptio of small signal and of the absence of any static field the fundamental equations are derived in on dimensional treatment. The dispersion relatio obtained from the fundamental equations is found t describe the behaviour of propagation of localize initial disturbances with electron beams. It is applie to the case of excitation of thermal plasma by a injected electron beam and the rate of wave growth i obtained. The numerical results are compared wit the circumstances corresponding to the investigatio

Merrill and Webb. The abrupt scattering of ron beams observed may be ascribed to the ation of plasma oscillations. A.

538.566

Penetration of an electromagnetic wave into a magnetic material. A. PAPOULIS. *J. appl. Phys.*, 169–76 (*Feb.*, 1954).

When a magnetic field is applied to the surface of a mination of a metallic ferromagnetic core, it does instantly penetrate into the interior because of the iced eddy currents. If the *B–H* curve of the core erial is a straight line, the computation of the field in the material can be performed with known hods. For a general *B–H* curve the resulting ation for *H* is nonlinear, and only a numerical ution is possible. The purpose of this paper is give an approximate solution for the case of a angular hysteresis loop material. The theoretical ults that are developed are in close agreement with experimental measurements described in this er. A.

538.566

Diffraction by two parallel planes of finite gth. W. E. WILLIAMS. *Proc. Cambridge Phil. Soc.*, *Pt* 2, 309–18 (1954).

The diffraction of a plane harmonic electromagnetic ve by two parallel, perfectly conducting planes of finite width and finite length is considered. The ve is assumed to be polarized perpendicular to edges of the plane, and thus the problem can also regarded as that of diffraction of a plane sound ve. Two integral equations are obtained, and the uations are solved approximately when the length the planes is large compared with the wavelength. e resonance of the system is also considered and equation obtained for the resonant lengths. This solved by an approximation depending on the sumption that twice the product of the wave mber (k) and the resonant length (l) is always ge. For the fundamental mode of an n-resonant stem (i.e. $kl \simeq n\pi$) when the plane separation is all compared with the wavelength this correction

$$\frac{d}{2\pi}\left(\log\frac{4\pi}{kd} - \gamma + 1 - \frac{1}{2\sqrt{n}}\right),$$

here γ is Euler's constant. A.

538.566 : 518.4

Graphs of functions arising in diffraction problems. *See Abstr.* 4088

538.566 : 535.42

Diffraction theory. *See Abstr.* 4425

538.566 : 621.396.67 : 621.396.11

General theory of plane-wave scattering from nite, conducting obstacles with application to the wo-antenna problems. J. E. STORER AND J. SEVICK. *appl. Phys.*, **25**, 269–76 (*March*, 1954).

The variational techniques of Levine and Schwinger re used to obtain an approximate solution for the ee-space scattering by a number of finite, perfectly nductive obstacles in which the mutual interactions r coupling are taken into account. The far-zone attered field is found in terms of the obstacle currents. Variational principles for the total and backscattering cross-sections are included. The special case of two parallel wires of finite length is worked out, and the results agree well with experiment. A.

538.566

4744. Electromagnetic waves excited by an elementary electric dipole in a cylindrical waveguide. Č. MUZIKÁŘ. *Czech J. Phys.*, **1**, *No.* 3–4, 127–33 (1952).

Equations are derived for the intensity of the electric and magnetic fields excited by an elementary oscillating electric dipole arbitrarily oriented in a cylindrical waveguide; the consequences of these equations are discussed. A.

538.566 : 621.385.1.029.6

4745. Some remarks on thermal effect in an electron beam on the gain of traveling-wave tubes. K. UDAGAWA AND M. SUMI. Letter in *J. appl. Phys.*, **25**, 135–6 (*Jan.*, 1954).

For background see Abstr. 4553 (1951). The results of Parzen and Goldstein are applied to the overall gain instead of the gain of the growing wave alone, and it is shown that the gain in low noise (beam current a few tens of μA) tubes may vary rapidly with cathode temperature. In a numerical example the gain for $kT = 0{\cdot}06$ V is 20 db, for $kT = 0{\cdot}08$ V, 11 db, and for $kT_c = 0{\cdot}10$ V, $-9{\cdot}54$ db. This example is based on abnormally low beam currents and circuit impedance and the effect would not be nearly so marked in a more conventional tube.

A. H. W. BECK

538.566 : 621.3.011.21 : 621.396.67

4746. The impedance of an antenna above a circular ground plate laid upon a plane earth. G. BEKEFI. *Canad. J. Phys.*, **32**, 205–22 (*March*, 1954).

Recent theoretical work by Storer, concerning the impedance of a vertical aerial in contact with a circular metal disk, is extended to include the case when the system is laid upon an imperfectly conducting plane earth. The expression for the impedance of the aerial is cast into a form which is stationary with respect to small variations (about the true value) of the unknown radial electric field over the surface of the earth. Numerical results are given for the case when the ground plate is sufficiently large as compared to the wavelength of the radiation; the effect of variations in dielectric constant of the earth upon the impedance is shown. These calculations are compared to those obtained from the approximate theory of Monteath. A second variational formula for the aerial impedance is developed in terms of surface currents flowing in the metal ground plate. The application of this method becomes useful when the ground plate is not too large in comparison with the wavelength. A.

538.566 : 621.396.11 : 621.372.8

4747. Coupling of modes of propagation. J. R. PIERCE. *J. appl. Phys.*, **25**, 179–83 (*Feb.*, 1954).

When two lossless modes of propagation are coupled, waves which increase or decrease with distance may arise when the power flow of the two modes is in opposite directions or when power is generated

in the coupling device. This behaviour is characteristic of wave filters, travelling-wave tubes, double-stream amplifiers, and space-charge-wave amplifiers. Such behaviour is analysed assuming linearity and conservation of energy only. A.

538.566.2 : 621.372.5 : 621.396.11

4748. Wave propagation in stratified media for normal incidence, and its application to circuit theory, electromagnetic waves, optics, acoustics, wave mechanics, and to mechanical and electrical quadripole networks. K. Altenburg and S. Kästner. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 1–43 (1953) *In German.*

The above phenomena in the one-dimensional case have the same two simultaneous first-order linear partial differential equations (or simultaneous difference equations) with constant coefficients, for which the general periodic solutions containing 3 complex constants, are obtained for a homogeneous (or discrete) medium. The transparency, reflection (and normal modes) for a set of finite layers (or discrete elements) are treated by a matrix method. Applications include anti-reflection films, transmission lines, concentric Lecher lines, tunnel effect, vibrations of infinite chain of coupled mass points, etc. Analogue computers for one type of system are discussed in terms of a system more amenable to experimentation. 67 references. F. ANSBACHER

538.566.2

4749. The constants in the equation for atmospheric refractive index at radio frequencies. E. K. Smith, Jr and S. Weintraub. *J. Res. Nat. Bur. Stand.*, **50**, 39–43 (*Jan.*, 1953).

For abstract, see Abstr. 8593 (1953).

538.566.2 : 621.396.11

4750. The anomalous propagation of radio waves in the 1–10 metre band. F. H. Northover. *J. atmos. terrest. Phys.*, **2**, *No.* 2, 106–29 (1952).

Anomalous propagation of metre waves, which is occasionally observed, cannot be explained as in the case of centimetre waves by the effects of surface inversions, but it may be caused by sharp inversions occurring at high levels. The theory developed shows that high level subsidence inversions, which sometimes occur, can in fact account satisfactorily for the anomalous propagation in the 1–10 m band. A.

538.566.3

4751. Conditions of coupling and reflection of ordinary and extraordinary electromagnetic waves in an inhomogeneous and anisotropic plasma (ionosphere). R. Jancel and T. Kahan. *C.R. Acad. Sci.* [*Paris*] **237**, 1657–9 (*Dec.* 21, 1953) *In French.*

Continuation of previous theory [Abstr. 5594, 7808 (1953)] allowing for the presence of a magnetic field. It is shown that if an e.m. wave travelling vertically in the ionosphere does not encounter a region of strong reflection it is resolved into ordinary and extraordinary components, but in a region of strong reflection the phenomenon of triple resolution occurs, the third component being usually of small amplitude. G. M. BROWN

538.566.3

4752. Coupled forms of the differential equations governing radio propagation in the ionosphere. P. C. Clemmow and J. Heading. *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 2, 319–33 (1954).

It is shown that the equations governing obl[ique] propagation in a horizontally stratified ionosp[here] with an oblique magnetic field can be cast into a f[orm] suitable for solution by successive approximati[ons]. In the general case this "coupled" form consists [of] four first order differential equations, each being a[s]sociated with one characteristic wave. In the spe[cial] cases (*a*) horizontal magnetic field, (*b*) plane of i[nci]dence perpendicular to the magnetic meridian, [two] second-order coupled equations of a particular t[ype] can be derived, each of which is associated with a [pair] of corresponding upgoing and downgoing cha[rac]teristic waves. These latter equations are similar, and include, those already given by Förster (1942) for vertical incidence. The cases in wh[ich] there is no coupling are briefly considered from [the] point of view of the first-order equations. T[he] general formulation provides a basis for assessing [the] validity of the standard "ray" approximation, alter[na]tive to that developed by Booker (1936), and bri[efly] out the nature of its breakdown in coupling a[nd] reflection regions. Specific applications and ext[en]sions of the theory are left for later consideration.

538.566.3 : 551.59

Short period fading under conditions of ionospher[ic] turbulence. *See Abstr.* 5190

538.566.3 : 621.396

4753. Oblique propagation of radio waves over [the] curved earth. B. Chatterjee. *Indian J. Phys.*, [**2**], 257–68 (*May*, 1953).

Booker's analysis (1938) of oblique propagation [of] radio waves through the ionosphere over a flat ear[th], taking into consideration the effect of terrestrial ma[g]netic field, has been extended to the case of the curv[ed] earth. This is done by introducing appropriate co[r]rection factors into the equations for the flat ear[th] case to take account of the curvature effect. It [is] found that for the case of curved ionosphere, the val[ue] of x, [$x = (4\pi e/mp^2)N$, where N is the ionizati[on] density] is higher at the point of reflection in t[he] deviating region. As a result of this, the values [of] group retardation, lateral deviation and attenuation [in] the deviating region as calculated for the curved ear[th] case, are higher than those for the flat earth. The[se] values for the curved earth are found to agree bett[er] with experimental results.

538.566.3 : 621.396.1

4754. The effect of ions on magneto-ionic characteristic polarization. W. Snyder. *Trans Inst. Radio Engrs, Prof. Group on Antennas and Propagation* **AP–1**, 23–7 (*July*, 1953).

There is some evidence for the presence of large numbers of ions in the *E*-region. Considering the recent increase in the precision with which sky-wave polarization measurements can be made, it seems desirable to fill a gap in the usual magneto-ionic theory by investigating the effect on the theoretical characteristic polarizations of introducing a mixture of ions and electrons into the calculations. A general formula is derived as an extension of the magneto-ionic polarization expression of Goubau. The 100 kc/s and 300 kc/s polarizations predicted by this formula

been plotted for a neutral mixture of oxygen ions, ogen ions, and electrons. The plots show that rizations are possible in a mixture that cannot ir when only electrons are present. They also w that characteristic polarizations in a mixture not define the medium parameters as completely hey do with electrons only. Another interesting ure is that the polarizations in a mixture depend on relative numbers of each type of charged particle seem not to depend on the actual charge density n the proportion of electrons is small. A.

538.566.9 : 621.372.8

5. *Corrigendum:* On the solutions of Maxwell's ations in an infinite medium etc. K. V. K. PRASAD. *ian J. Phys.*, **27**, 340 (*June*, 1953).

ee Abstr. 1980, 6643 (1952). It is now stated t these papers are very much based on the material he thesis by G. M. Roe, March, 1947, University Minnesota Library, U.S.A. Several of the equaıs presented in the above papers are wrong and the rect equations are found in the thesis referred to.

538.569.3 : 539.185.9

Radio-frequency absorption of solids after irradiation uclear reactors. *See Abstr.* 5011

MAGNETIC EFFECTS 538.6

538.61

56. Magnetic rotatory power (Faraday effect) ouvoir rotatoire magnétique (effet Faraday)]. DE MALLEMAN. **Magneto-optic Kerr effect** [Effet agnéto-optique de Kerr]. F. SUHNER. *Paris*: *ermann et Cie* (1951) 137 *pp.* [*Tables de constantes données numeriques. Constantes selectionnées*, 3] *French.*

Verdet constants, molecular magnetic rotatory wer and molecular rotativity are given for a number gases, mineral and organic liquids, and electrolytic lutions. Formula index. Bibliography of 514 ferences.

The Kerr effect is presented in tables and curves ving rotation, dispersion and ellipticity of the rromagnetic metals, as well as the rotation of Pt, u, Ag, Al and Bi. Bibliography of 77 references.

538.61 : 535.345.6

757. Magnetically controlled color filters. V. A. ABITS. *Optik*, **11**, *No.* 2, 61–74 (1954).

Gives the theory of magnetically controlled colour lters, which are based on the Faraday and on the otton–Mouton effects. A relationship is derived etween magnetic field and the chromaticity values of ie colours transmitted by the filters. Experimental sults are given for magnetically controlled colour lters of one and of two stages. A.

538.632

758. The Hall effect in Cs_3Sb photo-cathode. T. AKATA. Note in *J. Phys. Soc. Japan*, **8**, 793–5 *Nov.–Dec.*, 1953).

538.632

759. The Hall effect in bismuth at 1·4°K. J. M. REYNOLDS, T. E. LEINHARDT AND H. W. HEMSTREET. Letter in *Phys. Rev.*, **93**, 247–8 (*Jan.* 1, 1954).

Reports results of measurements on a single crystal. The Hall coefficient was found to be periodic in H^{-1}, H being the field strength (5×10^3–8×10^3 oersted), as are the magnetic susceptibility and magnetoresistance. E. P. WOHLFARTH

538.632 : 548.7

4760. Hall effect measurements on CdS crystals. H. DIEDRICH. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 349–52 (1953) *In German.*

Hall effect measurements were made on crystals irradiated with radiation covering the whole absorption region and of varying intensity. A relation was found between the electron mobility and the concentration of free electrons. A. E. DE BARR

538.632 : 621.317.38 : 621.315.59

4761. Application of the Hall effect in a semiconductor to the measurement of power in an electromagnetic field. H. M. BARLOW. Letter in *Nature* [*London*] **173**, 41–2 (*Jan.* 2, 1954).

It is shown how a germanium crystal can be used as a power meter when connected so as to observe the Hall effect. One application would be for measuring the power between a pair of heavy-current busbars. C. A. HOGARTH (R)

MOLECULAR AND ATOMIC STRUCTURE 539.1

539.1

4762. Approximate solutions of the Thomas–Fermi equation for atoms and molecules. H. C. BRINKMAN. *Physica*, **20**, 44–8 (*Jan.*, 1954).

A new method of solving the Thomas–Fermi equation for the electric potential in atoms and molecules is developed. The method is illustrated at the examples of a free atom and N_2. A.

THEORY OF SOLID STATE 539.11

539.11

4763. The electron theory of metallic magnesium. M. TRLIFAJ. *Czech. J. Phys.*, **1**, *No.* 3–4, 110–20 (1952).

Results are given on the calculations of the energetic spectra of valency electrons in metallic magnesium according to the method of Z. Matyáš [Abstr. 8968 (1952)] and on the basis of group analysis of the wavefunctions of valency electrons in a crystal. The binding energy was calculated and an attempt was made to explain the spectral distribution of the soft X-ray emission spectrum. An explanation is attempted of the quantitative changes in the dependence of the lattice constant of some solid solutions of multivalent metals in magnesium. In all cases the agreement with experiment is satisfactory. A.

539.11

4764. Vibrational spectrum of the simplest model of an ordering alloy. A. N. MEN' AND A. N. ORLOV. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 5, 753–6 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-160.

Theoretical. The method of "effective atoms" [A. A. Smirnov, *Zh. eksper. teor. Fiz.*, **17**, 730 (1947)] is used to discuss the vibrations of a linear chain consisting of two types of atoms which interact elastically and are distributed over the chain with an arbitrary degree of long-range order and with arbitrary relative concentration. The frequency spectrum consists of two branches separated by a forbidden interval; the velocity of the elastic waves is independent of, and the Debye temperature increases with, the degree of order. The consequences for the specific heat and electrical resistance of a partially ordered alloy are discussed. E. H. SONDHEIMER

539.11

4765. Nuclear magnetic resonance in metallic lithium and sodium. H. JONES AND B. SCHIFF. *Proc. Phys. Soc.* [*London*] *A*, **67**, 217–20 (*March*, 1954).

The magnitude of the change in the nuclear magnetic resonance frequencies in metals, with respect to the resonance frequencies of the same nuclei in chemical compounds, depends upon the nature of the electronic states at the surface of the Fermi distribution. In this paper it is shown that the observed "Knight-shifts" are in good agreement with the results of cellular-type calculations of the electronic states in metallic lithium and sodium. A.

539.11

4766. The calculation of the energy bands in diamond. V. ZEHLER. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 229–52 (1953) *In German.*

Two methods are used. The cellular method of Wigner and Seitz gives the width of the lower occupied band as 18·5 eV, in good agreement with experiment, but the width of the forbidden band (ΔE) is too small by a factor 4. Expansions of the wavefunctions in spherical harmonics satisfying the crystal symmetry are used, similar to v.d. Lage and Bethe's calculation [Abstr. 1918 (1947)] for Na. A better value for ΔE (5·89 eV) is obtained by a variational method using Fourier expansion and minimizing the electronic energy. F. ANSBACHER

539.11

4767. Band structure of graphite. J. L. CARTER AND J. A. KRUMHANSL. Letter in *J. chem. Phys.*, **21**, 2238–9 (*Dec.*, 1953).

Two conclusions from Wallace's theory [Abstr. 1864 (1947)] are critically examined. It is shown that a minute difference in the energy (~0·01 eV) of two pairs of atoms in the unit cell leads to a modified zone structure and a striking discontinuity in the density of states at the junction of upper and lower band. F. ANSBACHER

539.11

4768. Expansion of copper bombarded by 21-MeV deuterons. W. R. MCDONELL AND H. A. KIERSTEAD. Letter in *Phys. Rev.*, **93**, 247 (*Jan.* 1, 1954).

The observed bending of tubes of Cu during exposure on one side to deuterons is attributed to an isotropic expansion due to the production of vacancies and interstitials. The rate of bending at 25°c is ~1/10th that at −196°c, because of thermal annealing. A. D. LE CL...

53[illegible]

4769. On a property of binary iron alloys. T. OWE BERG. *J. Phys. Radium*, **15**, 99–100 (*Feb.*, 19[illegible] *In French.*

Discusses the conditions for the formation of alloy phases α and α' in binary systems containing and elements with higher atomic number, the α-ph being one with uniform electronic density and α'-phase having a non-uniform density [see a Abstr. 7069 (1951); 1508 (1954)]. E. P. WOHLFA...

539[illegible]

4770. On the exchange interaction in the collec electron approximation. R. H. TREDGOLD. *P Phys. Soc.* [*London*] *A*, **67**, 221–4 (*March*, 1954).

A brief discussion of the previous work on subject is given. A general expression for the excha integral in the collective electron approximation obtained in terms of the Fourier coefficients of exchange charge density. These coefficients evaluated for a particular case of tightly bou electrons and it is shown that the exchange integ is a strong function of the difference of the wa vectors characterizing the two states between wh exchange is considered. The significance of t result is discussed and the inadequacies of the c lective electron approximation in dealing w problems involving exchange are pointed out.

539[illegible]

4771. Cohesion of the alkali metals in the Thoma Fermi–Dirac theory. N. H. MARCH. *Phil. Ma* **45**, 325–8 (*March*, 1954).

It is pointed out that, contrary to the usual beli the Thomas–Fermi–Dirac method affords so explanation of metallic binding, and the resu predicted by the theory are presented.

539.11 : 536.6[illegible]

4772. Specific heats of simple solids and momen of elastic frequency spectra. J.-L. HWANG. Letter *J. chem. Phys.*, **22**, 154–5 (*Jan.*, 1954).

Several expressions are considered, but no choi can be made for the present accuracy of measureme of specific heats. C. TURN...

539.11 : 536.631 : 539.[illegible]

4773. The vibrational spectrum and the specific hes of germanium and silicon. Y.-C. HSIEH. *J. chem Phys.*, **22**, 306–11 (*Feb.*, 1954).

The vibrational spectra of Ge and Si have bee constructed by computation of 174 characteristi frequencies in 29 directions by Born's lattice theor as elaborated by Smith. Two approximations hav been considered, involving (*a*) the interaction betwee each atom and its first neighbours only, and (*b*) th interaction between the atom and its first neighbours and the central force interaction between the ato and its second neighbours. The specific heats o Ge and Si at low temperatures are calculated fro the spectra. The theory indicates a minimum of th Debye characteristic temperature in qualitative agree

t with the experiments, but fails to give quantita- agreement. A.

539.11

4. A quantum-mechanical calculation of the ace energy of crystalline lithium fluoride. B. M. E. DER HOFF AND G. C. BENSON. *J. chem. Phys.*, 475–80 (*March*, 1954).

his work is an extension of previous papers on energies of the LiF crystal and molecule. A ple form of distortion is permitted in the surface ion. The value of the surface energy of a {100} obtained from these computations is 557 erg $^{-2}$ at 0°K and is appreciably higher than results ed on classical considerations. A.

539.11 : 536.7 : 539.3 : 548.7

5. The ideal crystal at absolute zero. L. SALTER. *l. Mag.*, **45**, 360–8 (*April*, 1954).

Theoretical expressions for the internal energy, uilibrium volume and elastic constants of the rare solids at absolute zero are derived, using a recently posed approximation for the zero-point energy a crystal. The calculations show that, on the sis of a central force model, the zero-point energy stroys the equality $c_{12} = c_{44}$ (Cauchy relation) for se solids. A.

MOLECULAR STRUCTURE 539.13

539.13

76. On the inelastic collision between molecules. I. Rotational transitions in H_2 gas. K. TAKAYANAGI ND T. KISHIMOTO. *Progr. theor. Phys.*, **9**, 578–92 *une*); Erratum, **10**, 369 (*Sept.*, 1953).

For Pt II, see Abstr. 639 (1953). The same method approximation as in the previous paper has been ed to calculate the probabilities of rotational ansitions of para-hydrogen at the room temperature. hree types of the process are considered in which e rotational quantum numbers change as

$$\begin{cases} 2 \to 0 \text{ (the molecule)} \\ X \to X \text{ (the second molecule)} \end{cases}$$

$$\begin{cases} 4 \to 2 \\ X \to X \end{cases}$$

nd

$$\begin{cases} 4 \to 2 \\ 0 \to 2. \end{cases}$$

elative probabilities of these three processes at $' = 298{\cdot}4$°K explain the shape of the experimental urve obtained by Rhodes fairly well. The absolute alues of these probabilities, however, are a few times rger than the required values. The discrepancy of is order is inevitable to the extremely simplified ethod of calculation. The effect of the statistics for dentical molecules is discussed in the appendix. A.

539.13 : 530.162

777. The statistical mechanics of assemblies of xially symmetric molecules. I. General theory. . A. POPLE. *Proc. Roy. Soc. A*, **221**, 498–507 *Feb.* 9, 1954).

A general method for investigating the thermo- ynamic effects of the dependence of the inter- molecular potential on orientation is described. The intermolecular potential for axially symmetric molecules is expanded in such a way that the central-force part can be separated uniquely and the remaining directional parts classified in terms of various angular symmetries. Several simple types of directional intermolecular force are treated in this way as examples. The free energy of an assembly of such systems is then calculated by treating the directional parts of the field as a perturbation on the central-force part. This leads to a simple expression for the extra free energy due to directional forces in terms of the molecular distribution functions of an assembly of molecules interacting according to a central-force law. A corresponding treatment of multicomponent systems is also given. A.

539.13 : 530.162

4778. The statistical mechanics of assemblies of axially symmetric molecules. II. Second virial coefficients. J. A. POPLE. *Proc. Roy. Soc. A*, **221**, 508–16 (*Feb.* 9, 1954).

A general theory of the second virial coefficient of axially symmetric molecules is developed, the directional part of the intermolecular field being treated as a perturbation on the central-force part. The method is applicable to any type of intermolecular potential, particular models of directional interaction being obtained by suitable choices of parameters. Simple expressions are given for the second virial coefficient due to several types of directional force. The theory is illustrated by some calculations on the force field of carbon dioxide and its relation to the second virial coefficient and crystal data. These indicate that there is strong quadrupole interaction between carbon dioxide molecules. A.

539.13 : 533.7

The intermolecular potentials of helium and hydrogen. *See Abstr.* 4268

539.13 : 535.372

Phosphorescence bands of some carcinogenic aromatic hydrocarbons. *See Abstr.* 4406

539.132 : 535.338.4

Spectroscopic data concerning diatomic molecules. *See Abstr.* 4347

539.132

4779. Gaussian functions in molecular integrals. R. KIKUCHI. Letter in *J. chem. Phys.*, **22**, 148 (*Jan.*, 1954).

By a Laplace type transformation, $\exp(-r)$ can be written as the integral of a Gaussian function. This enables molecular integrals using ordinary exponentials, such as Slater wave functions, to be expanded rigorously in Gaussians. The expansion of a two-electron four-centre integral is given. This might be evaluated numerically. J. HAWGOOD

539.132

4780. The benzyl-hydrogen bond dissociation energy from electron impact measurements. D. O. SCHISSLER AND D. P. STEVENSON. Letter in *J. chem. Phys.*, **22**, 151–2 (*Jan.*, 1954).

Measurements of appearance potentials of $C_7H_7^+$ lead to $D(C_6H_5CH_2 - H) = 77 \pm 3$ kcal/mole.

R. F. BARROW

539.132

4781. On the fundamental vibrations of arsine. I. GAMO. *C.R. Acad. Sci.* [*Paris*] **238,** 465–7 (*Jan.* 25, 1954) *In French.*

The force constants of the fundamental vibrations of AsH_3 and AsD_3 were calculated from experimental frequency values with the use of the potential function of Urey and Bradley. It was found that there is some attraction between the H-atoms. A. J. TAYLOR

539.132

4782. Variation of the *l*-type doubling constant in HCN. J. F. WESTERKAMP. *Phys. Rev.*, **93,** 716 (*Feb.* 15, 1954).

Microwave measurements on six transitions between the *l*-type doublets of HCN show that the *l*-type doubling constant depends on rotational angular momentum J as follows:

$$q = 224{\cdot}471 - 0{\cdot}002613J(J+1) \text{ Mc/s.}$$ A.

539.132

4783. The development of a quantum-mechanical model for the lithium fluoride molecule. G. C. BENSON AND B. M. E. VAN DER HOFF. *J. chem. Phys.*, **22,** 469–75 (*March*, 1954).

A quantum-mechanical model of the LiF molecule is developed using four different forms of wave-functions. The most refined form considers the transfer of electrons to an excited state of the F^- ion and possible covalency of the bond. This leads to values of the binding energy, internuclear distance, and dipole moment which are in reasonable agreement with available data. The inclusion of about 11% covalent character is essential for the success of the model proposed. A.

539.132

4784. Vibrational spectra of benzene and deutero-benzenes: computation and interpretation. M. A. KOVNER. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 3, 499–502 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-104.

Previous data on the Raman and infrared spectra are analysed for the calculation of the force constants and the planar vibrational frequencies of C_6H_6, C_6H_5D, *p*-$C_6H_4D_2$, *s*-$C_6H_3D_3$, *p*-$C_6H_2D_4$ and C_6D_6. The calculated frequencies are compared with the experimental values and assignations made. The force constant matrix determined may be used to calculate the vibrational frequencies of alkyl benzenes and other aromatic compounds. G. I. W. LLEWELYN

539.132

4785. Vibrational spectra of formic acid (monomer) and its deuterosubstituted forms: computation and interpretation. L. M. SVERDLOV. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 3, 503–5 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-110.

The infrared and Raman spectra recorded by previous investigators are interpreted and assignations of the observed frequencies made. G. I. W. LLEWELYN

539.132

4786. Vibrational intensities in diatomic infrared transitions. The vibrational matrix elements for CO. R. C. HERMAN AND K. E. SHULER. *J. chem. Phys.*, **22,** 481–90 (*March*, 1954).

Second-order perturbation theory has been employed to obtain general formulae for the (rotationless) vibrational matrix elements of diatomic molecules in infrared transitions. The mechanical and electrical anharmonicities have been taken into account by expanding the potential function in a power series through quartic terms and the electric dipole moment through cubic terms in the internuclear separation. The formulae obtained in this manner are shown to be quite accurate for the fundamental and the first two overtones. These expressions were then employed to evaluate the vibrational matrix elements for CO ($^1\Sigma^+$) up to $v' = 4$ using the experimental integrated absorption coefficients as auxiliary data for the determination of the electric dipole moment expansion coefficients. A comparison of the vibrational matrix elements for CO involving the use of perturbed harmonic oscillator wave functions with those obtained using Morse wave functions with both linear and quadratic expansion of the electric dipole moment indicates that the Morse treatment is applicable through higher vibrational quantum numbers and higher transitions than the perturbation treatment. The comparison furthermore shows that the simple Morse expression with a linear expansion of the electric dipole moment yields vibrational matrix elements which would appear to be sufficiently accurate for many purposes. The anharmonic oscillator wave functions obtained would also prove useful in the evaluation of vibrational matrix elements in electronic transitions if the array for the harmonic oscillator overlap integrals were extended through higher vibrational quantum numbers.

539.132 : 535.338

4787. Relative transition probabilities in band systems of diatomic molecules. D. R. BATES. *Monthl. Not. Roy. Astron. Soc.*, **112,** *No.* 6, 614–36 (1952).

A set of tables is given from which it is possible to obtain quickly the relative probabilities if the spectroscopic constants r_e, ω_e and x_e are known. Two methods of using the tables are described. One is applicable if the electronic transition causes a small or moderate change in the equilibrium internuclear separation; and the other is applicable if the change is moderate or large. The first method is not significantly less accurate than the Morse approximation. Though the second method does not yield results of such high precision, it should be useful for many purposes.

539.132 : 535.343–1

Vibration-rotation bands and molecular constants of carbonyl sulphide. *See Abstr.* 4379

539.132 : 535.343.4–1

Molecular constants of DBr. *See Abstr.* 4381

539.132 : 537.226.

Dielectric losses in polar molecules with several internal rotation axes. *See Abstr.* 4505

539.132 : 541.5

4788. An interpretation of vibration spectra and computation of the potential energy parameters of deuteroethylenes. L. M. SVERDLOV AND N. L. PAKHOMOVA. *Dokl. Akad. Nauk SSSR*, **91,** *No.* 1, 51–4 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-80.

Computations of the vibration spectra of partially

erated ethylenes from ethylene force-constants, g the interpretation of the C_2H_4 and C_2D_4 spectra oted in 1949 (Herzberg), show that this inter- ation needs modification. From the modified pretation the force constants, and the elements of inverse matrix, corrected for anharmonicity, are lated for planar and non-planar vibrations of deutero-ethylenes; the vibration spectra thus puted agree well with experiment, the mean r being 6 cm^{-1} and maximum error 28 cm^{-1}. C=C bond force-constant is $14{\cdot}2\times10^6$ cm^{-2} 6×10^5 dyne/cm) that for the C–H bond 3×10^6 cm^{-2} ($5{\cdot}08\times10^5$ dyne/cm), and that for the tive twisting of the CH_2 groups $0{\cdot}755\times10^6$ cm^{-2} 45×10^5 dyne/cm). The modified interpretations he spectra agree with those of Arnett and Crawford str. 4252 (1950)] and Lancaster, Inskeep and wford [Abstr. 6128 (1951)], except for the value $\nu_5(B_{1g})$ for C_2H_4, given here as 3076 cm^{-1}, and for erchange of assignment of ν_7 and ν_8 for C_2H_3D, ν_4 and ν_7 for C_2HD_3, and of ν_5 and ν_9 for $C_2H_2D_2$. J. HAWGOOD

539.132 : 535.338.4

89. Triplet electronic states of aluminium monoxide. P. G. DODSWORTH AND R. F. BARROW. Letter in *Proc. Phys. Soc.* [*London*] *A*, **67**, 94–5 (*Jan.*, 54).

Vibrational analyses of two new systems, probably $^3\Pi \rightarrow {}^3\Pi$, have been carried out. The lower state is the lower state of the transition $b(^3\Sigma) \rightarrow a(^3\Pi_r)$ at 00 Å [Abstr. 4699 (1953)]. The levels $v = 0$ of the w states c and d lie at 36 017 and 38 624 cm^{-1} above $= 0$ of $a^3\Pi_1$: the values of $\Delta G_{\frac{1}{2}}$ are $930{\cdot}_7$ and $9{\cdot}_4$ cm^{-1} for c and d respectively. R. F. BARROW

539.132

90. Evaluation of some electron repulsion integrals eded in molecular quantum mechanics. II. Use of Neumann expansion in evaluation of two electron ree-center repulsion integrals. R. S. BARKER AND EYRING. *J. chem. Phys.*, **22**, 114–19 (*Jan.*, 1954). For previous part, see Abstr. 5623 (1953). Formuion of two types of three-centre electron interaction tegrals in convergent series is explicitly considered. hese expressions place no restrictions on the effective nclear charges of the composite atomic orbitals. he basic expansions are made in elliptical coordinates. The auxiliary functions used are discussed detail and when of known form, references to the iginal literature are cited. Examples arising in the iatomic hydrogen molecular complex are given. ossibilities of extension of the method to complex olecules are pointed out. A.

539.132

91. The relation between energy levels of substituent groups and electron migration effects in some onosubstituted benzenes. S. NAGAKURA AND J. ANAKA. *J. chem. Phys.*, **22**, 236–40 (*Feb.*, 1954).

Determinations of the highest occupied (H_B, H_S) d the lowest vacant levels (V_B, V_S) were made with enzene and some substituent groups using experiental knowledge of their ionization potentials and eir near ultraviolet absorption spectra. On the sis of the relative height of these levels, monobstituted benzenes can be classified into following ree groups: (1) $|V_S - H_B| < |V_B - H_S|$ for meta-directing molecules: (2) $|V_S - H_B| > |V_B - H_S|$ for ortho-, para-directing molecules: (3) $|V_S - H_B| \simeq |V_B - H_S|$ for styrene. By the aid of a simple quantum-mechanical treatment, it becomes sure that in the case of (1) the interaction between levels V_B and H_S is predominant and the migrating electron flows out of benzene into the substituent: on the other hand in the case of (2) the interaction between levels V_B and H_S is the stronger and the migrating electron moves in the reverse direction: and finally, in the case of (3), both interactions referred to in the foregoing should be taken into account with almost equal importance. Furthermore, it was shown that the difference in the ionization potential between the meta- and the ortho-, para-directing monosubstituted benzenes can be interpreted by taking into consideration the interaction of H_B with H_S or V_S, and that the absorption bands in the wavelength region 2300 ~ 2600 Å, observed with meta-directing molecules, may be regarded as due to the transition between two levels which occur by the interaction between levels V_S and H_B. A.

539.132

4792. Electronic structure of the amylose-iodine complex. H. MURAKAMI. *J. chem. Phys.*, **22**, 367–74 (*March*, 1954).

The electronic structure of the amylose-iodine complex is studied on a different basis from that of the previous Stein–Rundle theory. First, the electron transfer from amylose oxygen to the iodine molecule is discussed from the viewpoint of Mulliken's intermolecular charge-transfer spectra. Then it is shown that the consideration of electronic interaction between neighbouring iodine molecule ions and bond formation between oxygen and iodine gives a reasonable interpretation of bond number and absorption spectra. Last, the quantitative discussion of absorption spectra is performed by the application of the free-electron model to the system (I_4^{--}), taking this as the elemental unit in the polyiodine chain. The agreement between predicted and observed results is satisfactory if one considers the extreme simplification of the model. A.

539.132

4793. Some observations of double- and triple-quantum transitions. P. KUSCH. *Phys. Rev.*, **93**, 1022–4 (*March* 1, 1954).

Data are presented which show that it is possible to observe transitions for which $\Delta J = 0$, $\Delta m_J = \pm 2$ or ± 3 in a molecule characterized by a total angular J. It is also possible to observe transitions for which $\Delta F = 0$, $\Delta m_F = \pm 2$ or ± 3 in an atom characterized by a total angular momentum F. In each case the process occurs by the absorption or stimulated emission of two or three equienergetic quanta. A.

539.132 : 535.343

The electronic spectra of cata-condensed hydrocarbons. *See Abstr.* 4352

539.132 : 535.343.4–15

l-type doubling in C_2H_2 and HCN. *See Abstr.* 4382

539.132

4794. A note on the Franck–Condon principle. A. JABŁOŃSKI. Letter in *Acta phys. Polon.*, **11**, *No.* 2, 195–6 (1952).

Transition probabilities for the nuclear motion are

derived from the continuity requirement for the nuclear wave function before and after the sudden change of the nuclear potential due to an electronic transition (sudden approximation method). F. ANSBACHER

539.132

4795. Zeeman splitting of nuclear quadrupole resonance lines. Y. TING, E. MANRING AND D. WILLIAMS. Letter in *Phys. Rev.*, **92**, 1581 (*Dec.* 15, 1953).

In general four Zeeman lines may be observed in the quadrupole resonance spectrum of Cl in $NaClO_3$, but with the 111 crystal plane $\perp$ to H only two lines are obtained whose splitting is expected to be strictly proportional to H and this has been verified from 0–8000 gauss. D. H. WHIFFEN

539.132

4796. Nuclear quadrupole coupling in polar molecules. H. M. FOLEY, R. M. STERNHEIMER AND D. TYCKO. *Phys. Rev.*, **93**, 734–42 (*Feb.* 15, 1954).

The effect of an external charge on the nuclear electric quadrupole coupling has been investigated for various ions. These results presumably apply to the case of polar molecules. The quadrupole moment induced by the nuclear quadrupole moment Q is $46{\cdot}5Q$, $8{\cdot}7Q$, $50{\cdot}2Q$ and $86{\cdot}8Q$ for the Cl^-, Cu^+, Rb^+ and Cs^+ ions, respectively. When an external charge interacts with the ion as in a polar molecule, the induced moment is added to Q, so that the quadrupole coupling is multiplied by a factor of order 10–100. This model of a polar molecule disregards the exchange repulsion between the ions. Evidence is presented from several molecules which seems to confirm the existence of the induced quadrupole moment, although there is only partial agreement with the experimental values. It is shown that the contribution to the quadrupole coupling due to the induced dipole moment in second order is small compared to the induced quadrupole effect. A.

539.132

4797. Nuclear quadrupole couplings in solid bromides and iodides. H. ROBINSON, H. G. DEHMELT AND W. GORDY. *J. chem. Phys.*, **22**, 511–15 (*March*, 1954).

From measurements of pure nuclear quadrupole transitions at 77°K the following coupling constants (in Mc/s) and asymmetry parameters have been obtained: for I^{127} $|eQq| = 1765{\cdot}846$, $\varepsilon^2 = 0{\cdot}00078$ in CH_3I; $|eQq| = 1897{\cdot}368$, $\varepsilon^2 = 0{\cdot}00736$ in CH_2I_2; $|eQq| = 2046{\cdot}634$, $\varepsilon^2 = 0{\cdot}00033$ in $CHI_3 . 3S_8$; $|eQq| = 2130{\cdot}33$ for CI_4; $|eQq| = 2069{\cdot}17$ for CF_3I; $|eQq| = 1324{\cdot}788$ and $1333{\cdot}313$, $\varepsilon^2 = 0{\cdot}000082$ and $\leqslant 0{\cdot}000010$ for the two non-equivalent I's in unit cell of SiI_4; $|eQq| = 1484{\cdot}339$ and $1500{\cdot}577$, $\varepsilon^2 = 0{\cdot}000087$ and $\leqslant 0{\cdot}000005$ for the two non-equivalent I's in unit cell of GeI_4; $|eQq| = 1384{\cdot}424$ and $1394{\cdot}190$, $\varepsilon^2 = 0{\cdot}000085$ and $\leqslant 0{\cdot}000016$ for the two non-equivalent I's in unit cell of SnI_4; $|eQq| = 1517{\cdot}07$, $\varepsilon^2 = 0{\cdot}00008$ in $AsI_3 . 3S_8$; $|eQq| = 1226{\cdot}35$, $\varepsilon^2 = 0{\cdot}00101$ in $SbI_3 . 3S_8$. The coupling values of Br are: $|eQq(Br^{79})| = 437{\cdot}27$ and $441{\cdot}15$; $|eQq(Br^{81})| = 365{\cdot}272$ and $368{\cdot}514$ for the two non-equivalent Br's in unit cell of PBr_3 ($T = 87 \pm 4°K$); $|eQq(Br^{79})| = 329{\cdot}000$ and $345{\cdot}920$; $|eQq(Br^{81})| = 274{\cdot}856$ and $288{\cdot}980$ for the two non-equivalent Br's in unit cell of $SbBr_3$. From these coupling values the number of unbalanced p electrons in the atoms is calculated. The latter quantity was found to be closely related to chemical bond properties such as ionic character, and was found to vary systematically with chemical constitution. A cross-bonding mechanism involving d orbitals is proposed to account for the iodine coupling in certain solids.

539.132 : 539.1

4798. Concentration shift of nuclear magnetic resonances in some concentrated acids. Y. MASUDA AND T. KANDA. *J. Phys. Soc. Japan*, **9**, 82–7 (*Jan.–Feb.*, 1954).

Chemical shifts of nuclear magnetic resonances are caused when two nuclei of the same kind have different magnetic shieldings caused by their environments. When there are two species of molecules having a chemical shift between them and if they are exchanging their states very rapidly by chemical reaction, their nuclear magnetic resonances cannot be observed separately but a single resonance is observed at the position of the field averaged over the two states with a weight of their population. Such resonances were observed for N^{14}, Cl^{35}, I^{127} and I^{127} in concentrated aqueous solutions of HNO_3, $HClO_4$, HCl, HBr and HI, respectively. In these cases, the chemically exchanging states are ions and undissociated molecules and from the measurement of the shifts some knowledge of the concentrated acid solutions can be obtained, such as the degree of dissociation, the type of the undissociated molecule etc. All the nuclei examined here have quadrupole moments, and from the measured line width in HCl, HBr and HI, it was concluded that the undissociated molecules are not HCl, HBr and HI molecules, which possess large quadrupole couplings, but some other molecules which have much smaller quadrupole couplings.

539.

4799. A nuclear magnetic resonance investigation of *n*-pentane, *n*-hexane and *cyclo*pentane. F. A. RUSHWORTH. *Proc. Roy. Soc. A*, **222**, 526–41 (*March* 1954).

The nuclear magnetic resonance spectra and spin lattice relaxation times were measured for the proton in *n*-pentane (C_5H_{12}), *n*-hexane (C_6H_{14}) and *cyclo*pentane (C_5H_{10}) all in the solid state. The temperature range covered was from 70°K to the melting-points 143·4°K for *n*-pentane, 177·8°K for *n*-hexane and 179·4°K for *cyclo*pentane. In the case of *n*-pentane and *n*-hexane the second moments of the absorption lines were found to be smaller than the computed rigid lattice values over the whole temperature range. Possible molecular motions which might cause this reduction are discussed. It is suggested that the most probable type of motion is reorientation of the methyl groups at the ends of each molecule about the adjacent C–C bonds. An analysis of the spin-lattice relaxation times shows that this reorientation process is governed by an activation energy of 2·7 kcal/mole for *n*-pentane and 2·9 kcal/mole for *n*-hexane, values which support the mechanism postulated. At the lowest temperatures the absorption lines had not reached their full width even though the reorientation frequencies at the temperatures were considerably less than the line widths. The experimental second moment for *cyclo*

bane below about 120°K indicates that the lattice effectively rigid in this temperature region. The rtainties in both the experimental and theoretical nd moments do not allow a distinction to be vn between the plane and puckered molecular iels. At the temperature of the first transition ·4°K) the line-width second moment and relaxa- time all show a sudden decrease. The low value cond moment at the higher temperatures indicates considerable molecular motion is occurring, the ecules rotating with spherical symmetry. The nge in crystal structure at the temperature of the nd transition (138·1°K) is thought to be a direct lt of this spherical symmetry. As the temperature eases, the results indicate that more molecular tion must be occurring, and it is thought that the ating molecules are diffusing through the lattice. A.

539.132 : 539.133

0. Dipole moments, nuclear quadrupole coupling, l the bonding orbitals in group V trihalides. P. SLIUK. *J. chem. Phys.*, **22**, 86–92 (*Jan.*, 1954).

By means of microwave spectral measurements the lowing molecular parameters were determined: The dipole moment of NF_3 is $0{\cdot}235 \pm 0{\cdot}007$ bye. (2) The nuclear quadrupole coupling of enic in $AsCl_3$ is -173 ± 20 Mc/s. (3) The inter- clear distance Sb — Cl and the bond angle — Sb — Cl are $2{\cdot}325 \pm 0{\cdot}005$ Å and $99{\cdot}5 \pm 1{\cdot}5°$, pectively, in $SbCl_3$. The measured molecular rameters of the group V trihalides are assembled d interpreted in terms of $s - p$ hybridization, rtial ionic and partial multiple bond character. In rticular, certain regularities in the dipole moments e pointed out which indicate that apparent omalies in the dipole moments of these molecules n be understood in terms of $s - p$ hybridization. om the evidence of nuclear hyperfine structure, it pears that NF_3 and AsH_3, as was previously ggested for NH_3, have an $s - p$ hybridization which not simply related to the bond angles. The quad- pole coupling per p-electron of N^{14}, previously ported to have been established by the measurements NF_3, has been again thrown open to question. A.

539.132

301. Hybridization of atomic orbitals in formation f molecules. I. FISCHER-HJALMARS. *Ark. Fys.*, **7**, *aper* 15, 165–83 (1953).

The condition of maximum penetration, previously ggested [Abstr. 5947 (1952)] by the present author, as been generalized and studied in more detail. It as been shown that the composition of the bonding tomic orbital, found by this condition, is remarkably ifferent from the bonding atomic orbital, found by he condition of maximum overlapping. The differ- nce is substantially due to the fact that there is a onsiderable difference in orbital energies between the tomic $2s$ and $2p$ orbitals. It is suggested that this ifference is important for the determination of the hape of the molecules NH_3 and H_2O. A.

539.132

802. On the origin of the anisotropy energy of $CuCl_2 . 2H_2O$. T. MORIYA AND K. YOSIDA. *Progr. heor. Phys.*, **9**, 663–74 (*June*, 1953).

The anisotropy energy of $CuCl_2 . 2H_2O$ having n orthorhombic symmetry can be expressed by $K_1\beta^2 + K_2\gamma^2$, where β and γ are the direction cosines of the magnetic moment with respect to the b-axis and the c-axis. The calculated value of K_2 arising from the magnetic dipole interaction nearly accords with the experimental value, but that of K_1 becomes much smaller. Since the magnitude of the spin of $CuCl_2 . 2H_2O$ is equal to 1/2, the crystalline field cannot produce any anisotropy energy, so that the part of the anisotropy energy other than that from the magnetic dipole interaction must be considered to arise from the anisotropic exchange interaction which has originally been proposed by Van Vleck. Therefore, the anisotropic exchange interaction is derived on the basis of the perturbation method and the anisotropy constants K_1 and K_2 due to this interaction are estimated by use of the experimental g-values which relate to the energy differences between the ground state and the excited states of Cu^{2+} ions. Thus it is shown that the sum of theoretical anisotropy constants due to both origins gives values of the same order as those obtained experimentally. A.

539.132

4803. Proton magnetic resonance spectrum of ammonia, and the interactions involved in hydrogen bond association. R. A. OGG, JR. *J. chem. Phys.*, **22**, 560–1 (*March*, 1954).

High-resolution proton magnetic resonance spectra are presented for the liquid and vapour states of ammonia. The vapour spectrum displays the expected spin-spin interaction multiplet structure. This is likewise found in the liquid state, provided the ammonia is rigorously anhydrous. A trace of water results in the appearance of a single resonance—an effect attributed to chemical exchange of protons. A marked shift of resonance between the liquid and vapour states is found, interpreted as decreased shielding in the liquid state. This effect, not observed for the non-polar substance propane, is discussed in connection with so-called "hydrogen bonding." A.

539.132

4804. Hyperconjugation. I. Conjugation and hyperconjugation energies. C. A. COULSON AND V. A. CRAWFORD. *J. Chem. Soc.*, **1953**, 2052–8 (*July*).

By improved calculations for a series of methylbenzenes and -ethylenes the hyperconjugation energy per methyl group has been found to be constant. A detailed comparison of the empirical and theoretically computed delocalization energies of benzene and butadiene yields a value of approximately —74 kcal. for β_0, the resonance integral (including overlap) for the C=C bond distance of 1·39 Å. The strengthening of single and double bonds by hyperconjugation is found to be less than previous estimates, the total contribution of third-order conjugation to the bond energies of both single and double bonds being only about 1·6 kcal. A.

539.132

4805. Hyperconjugation. II. Charge distributions in propulene and some methylbenzenes. V. A. CRAWFORD. *J. Chem. Soc.*, **1953**, 2058–61 (*July*).

The π-electron densities in propylene and some polymethylbenzenes have been computed theoretically and correlated with their substitutional reactivity. The effect of successive methyl substituents on the charge distribution in the benzene ring is found to be

strictly additive. Attention is drawn to the need for caution in deducing the manifestation of the hyperconjugative effect from inadequate studies of rates of reaction. A.

539.132

4806. Hyperconjugation. III. Bathochromic shifts resulting from methyl substitution in conjugated systems. V. A. CRAWFORD. *J. Chem. Soc.*, **1953**, 2061–5 (*July*).

A molecular-orbital calculation of the frequency of absorption of methyl-substituted ethylenes and benzenes has been made and the results compared with experiment. In agreement with Mulliken it is concluded that the red shifts in the spectra result chiefly from hyperconjugation. A.

539.132

4807. On the potential barriers which characterize substitution reactions on the atoms of polyene chains which carry a substituent or a heteroatom. O. CHALVET AND M. ROUX. *C.R. Acad. Sci.* [*Paris*] **237**, 1521–3 (*Dec.* 9, 1953) *In French.*

The contributions from π-electrons are determined by the LCAO method for substitutions on the extreme atom opposite to X; where X is at one end of the chain, carrying 1 or 2 π-electrons. For a nucleophyle reaction the barrier is reduced by introduction of a substituent or heteroatom more electronegative than C. J. JACOBS

539.132

4808. On the potential barriers which characterize simultaneous addition reactions on the bonds of polyene chains which carry a substituent or a heteroatom. O. CHALVET AND M. ROUX. *C.R. Acad. Sci.* [*Paris*] **237**, 1698–700 (*Dec.* 21, 1953) *In French.*

See preceding abstract. An extension to the case of the extreme bond opposite to X, for addition reactions of nucleophyle or electrophyle type.

J. JACOBS

539.132

4809. On the use of atomic term values in molecular wave functions. C. W. SCHERR. Letter in *J. chem. Phys.*, **22**, 149–50 (*Jan.*, 1954).

The approximations involved in the H_2 case suggested by various authors are tested: suitable orbital exponents for ionic and atomic parts of the wave-function and the substitution of experimental atomic term values in some energy integrals. The latter approximation was very successful. J. JACOBS

539.132

4810. Configuration interaction in butadiene calculated by the self-consistent molecular field method. A. PULLMAN AND J. BAUDET. *C.R. Acad. Sci.* [*Paris*] **238**, 241–3 (*Jan.* 11, 1954) *In French.*

As the usual self-consistent field method does not give satisfactory results with respect to spectroscopic transitions, the influence of configuration interaction was estimated. Calculations were carried out for the *trans*-form; nine first-excited singlet configurations of A_g symmetry and all the B_u configurations were taken into account. Energies, electric charge distributions, the transition $N \rightarrow V_1$ and $N \rightarrow V_2$ and their intensities were calculated. Configuration interaction decreases the energy of the lowest state by 2·2 eV; the energy of the lowest B_u state is decreased by only 0·66 eV; the first transition ($N \rightarrow V_1$) is shifte shorter wavelengths, which agrees better with ex ment. The first excited A_g state is decreased siderably; the transition $N \rightarrow V_2$ is close to experimental value. The values found for the tensities are improved by this method. A. J. TAY

539

4811. Extension of the method of the self-consis molecular field to the study of states having incom shells. G. BERTHIER. *C.R. Acad. Sci.* [*Paris*] 91–3 (*Jan.* 4, 1954) *In French.*

The states in question are those in which no orbitals are occupied by two electrons of oppo spins. As the Fock equations are now different singly and doubly occupied orbitals, the orthogon of the orbitals is no longer automatic. Accordi the orbitals are now divided into two sets, one each kind of spin-factor. These within one set now orthogonal, being determined by one set of F equations, whilst two in different sets are orthogo by virtue of different spin factors. The metho immediately applicable to molecular (includ radical) states representable by a single determinan one-electron functions. Calculations for a indicate a dipole moment of 0·095 *D*, and show agreement with observation, that the radical nat of alkyl is not manifested by an important bat chromic shift in the electronic spectrum. A. J. TAYL

539.

4812. On the method of molecular orbitals applied the study of σ-bonds. (Saturated hydrocarbons a their derivatives, the σ-part of multiple bonds.) SÁNDORFY AND R. DAUDEL. *C.R. Acad. Sci.* [*Pa* **238**, 93–5 (*Jan.* 4, 1954) *In French.*

As molecular orbitals expressed as linear co binations of equivalent orbitals do not give ve satisfactory results, when applied to σ-bonds, the u is suggested of linear combinations of hybrid bon instead. Relations have been derived for the charg the bond charges having special significance for t σ-bonds. These were calculated for bond chai having one non-carbon atom at the end, suitab parameters being chosen and resonance other th between nearest neighbours and hybrids of the sa atom being neglected. Atomic charges alternated, b the bond charges showed a steady decrease along t chain, being highest near the alien atom when this w more electronegative than carbon. A. J. TAYL

539.1

4813. Separable linear systems. R. GOUARN *C.R. Acad. Sci.* [*Paris*] **238**, 95–7 (*Jan.* 4, 1954) *French.*

Some mathematical results are derived whic facilitate the factorizing of the secular determinan which arise in the theory of molecular electron structure. The order of a set S of linear homo geneous simultaneous equations may be lowered b elimination of a set of variables (the separabl variables) each of which is connected through th system S only with variables not in the set. theorem predicts the multiplicities of the roots of th characteristic equation of the system. Successiv separations may be possible, the set of equation resulting from separating a set of variables being itsel separable. A. J. TAYLO

539.132

4814. The study of diacetylene by the self-consistent molecular field method. J. SERRE. *C.R. Acad. Sci. [Paris]* **238,** 243–5 (*Jan.* 11, 1954) *In French.*

Only π-electrons were considered, the others being included in the nuclear skeleton. Three- and four-centre integrals were evaluated by the Sklar formula. The resonance energy (0·455 eV) was slightly larger than that of butadiene. Charge distribution, ionization potential, and some electronic transitions were also estimated. The $N \rightarrow V_1$ transition showed a bathochromic effect with respect to butadiene, and an isochromic with respect to acetylene, though the latter is contrary to experimental results. This may be due to approximations in the evaluation of the multicentred integrals. A. J. TAYLOR

539.132

4815. Determination of some carbon–chlorine bond dissociation energies. M. SZWARC AND J. W. TAYLOR. *J. chem. Phys.*, **22,** 270–4 (*Feb.*, 1954).

An investigation of the pyrolyses of benzyl chloride and benzoyl chloride was carried out by means of the "toluene carrier" technique. It is shown that the course of these reactions is analogous to that of the previously investigated pyrolyses of benzyl bromide and benzoyl bromide, i.e. the rate determining steps

$$C_6H_5.CH_2Cl \rightarrow C_6H_5.CH_2 + Cl \text{ or}$$
$$C_6H_5.CO.Cl \rightarrow C_6H_5\,CO + Cl.$$

From kinetic data the activation energies of the rate determining steps were obtained, and these activation energies identified with the respective C–Cl bond dissociation energies. Thus the following values were obtained,

$$D(C_6H_5.CH_2 - Cl) = 68 \text{ kcal/mole, and}$$
$$D(C_6H_5.CO. - Cl) = 73{\cdot}2 \text{ kcal/mole.}$$

The consistency of these data with the respective C — Br bond dissociation energies is very satisfactory. For example, the heat of formation of the benzoyl radical, derived from the $D(C_6H_5.CO - Cl)$, is 15·7 kcal/mole, and that calculated from the experimentally determined $D(C_6H_5.CO - Br)$ is 15·6 kcal/mole. A.

539.132

4816. The valence bond theory of molecular structure. I. Orbital theories and the valence-bond method. R. MCWEENY. *Proc. Roy. Soc. A,* **223,** 63–79 (*April* 7, 1954).

The molecular orbital (MO) and valence bond (VB) theories of the electronic structure of molecules emerge from one quite general approximation method involving the use of anti-symmetrized products (AP's) of one-electron wavefunction ("orbitals"), differing fundamentally only in their choice of a first approximation; in MO theory this is usually a single AP, and the orbitals are non-localized molecular orbitals, but in VB theory it is always a combination of many AP's, the orbitals being localized atomic orbitals. The MO theory lends itself well to rigorous formal development and has recently been employed in essentially *ab initio* calculations; but a corresponding development of the existing VB method is precluded by the technical necessity of neglecting large numbers of non-vanishing integrals. The present papers are devoted to a reformulation of the VB method in which the usual difficulties are circumvented; the revised method is no less powerful than an MO approach in which full configuration interaction (i.e. refinement of the wavefunction by addition of "excited state" AP's) is admitted. The first paper (Pt I) is essentially preparatory. Orbital theories involving many AP's are discussed generally but with emphasis on the origin and concepts of the VB approach. Analysis of the charge distribution in a molecule is then shown to provide a unified description of chemical bonding and a general method of defining a "bond order," applicable in any orbital theory. Against this background the existing VB theory is critically discussed. The validity of the whole approach rests upon the assumption of approximate orthogonality of the basic orbitals; an attractive method of making the theory rigorous, whilst retaining its normal structure, would therefore involve the use of accurately orthogonal basic orbitals. But a treatment of the hydrogen molecule along such lines leads to an apparent paradox; the formally "covalent" VB structure describes only strong repulsion between the "bonded" atoms. This paradox is resolved and certain general characteristics of the revised VB theory are tentatively inferred. A.

539.133 : 335.338.4

The dissociation energy of SiS. *See Abstr.* 4348

539.133

4817. A system of secular equations relative to a molecular skeleton with axes of symmetry. I. SAMUEL. *C.R. Acad. Sci. [Paris]* **238,** 348 (*Jan.* 18, 1954) *In French.*

In setting up the usual secular determinant, indices characterizing atoms or bonds are retained. In this way the effect of a heteroatom can be traced throughout; and non-symmetrical molecules can be made symmetrical by the introduction of fictitious atoms for which the parameters are then equated to zero. J. JACOBS

539.133

4818. Symmetry and stability in diborane and in borine. G. W. CASTELLAN. *J. chem. Phys.*, **22,** 536–8 (*March*, 1954).

On the basis of the electronic state of diborane in the ethane structure proposed by Mulliken, a group theoretical theorem due to Jahn and Teller shows that the ethane structure is not a possible structure for diborane; a non-totally-symmetric vibration will move the molecule to a more stable configuration of lower symmetry. Any of the common bridge structures on the other hand are possible structures for diborane. The ethane structure is a permissible structure for $B_2H_6^=$. The argument is applied to the hypothetical molecule BH_3 but the conclusion is that the instability of this molecule is not due to symmetry. A.

539.133 : 535.343.4–14

Structure and dipole moment of stable pentaborane. *See Abstr.* 4375

539.133

4819. Isotope effect on the dipole moments of diatomic molecules. A. P. ALTSCHULLER. Letter in *J. chem. Phys.*, **21,** 2241–2 (*Dec.*, 1953).

The electrostatic treatment proposed by Bell [*Trans*

Faraday Soc., **31**, 1345 (1935)] for the effect of isotopic substitution on the dipole moments of diatomic molecules is applicable to the highly ionic alkali halides. The differences of dipole moments for several pairs of isotopic alkali halides have been calculated using this treatment and generally the values of $\Delta\mu$ are of the order of 10^{-4} *D*, except for the lithium halides, where the difference is much greater. G. I. W. LLEWELYN

539.133

4820. Relation between bond length and stretching frequency for the carbonyl group. M. MARGOSHES, F. FILLWALK, V. A. FASSEL AND R. E. RUNDLE. *J. chem. Phys.*, **22**, 381–2 (*March*, 1954).

A plot is shown of bond length *v.* stretching frequency of the carbonyl group in a series of compounds containing this group. For bond lengths ranging from 1·13 to 1·31 Å, the average distance of the points from a smooth curve is 0·013 Å. A.

539.133 : 535.343.4–15

The near infrared spectrum and the internuclear distances of nitrous oxide. *See Abstr.* 4383

539.133

4821. On the stretching of polymer chains. M. V. VOL'KENSHTEĬN AND O. B. PTITSYN. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 6, 1313–16 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-134.

A one-dimensional model of a flexible polymer is investigated by the method of Markov chains. Expressions for the mean sq. length in the stretched and unstretched condition are found. The force to transform the coiled into the uncoiled polymer and the elastic force to produce this change are derived from the entropy and the energy respectively. These cancel for small stretching leaving only the force necessary for the spatial orientation of the chains. J. E. CAFFYN

539.133

4822. The statistic shape of chain molecules. II. The general solution of the special random movement problem. G. POROD. *Acta phys. Austriaca*, **8**, *No.* 2, 181–90 (1953) *In German.*

For Pt I, see Abstr. 2664 (1954). This is calculated for n equal vectors in 3 dimensions. The general function for the distance density distribution for any n is derived from a function which expresses the density for n as an integral of a function of $(n-1)$. C. TURNER

539.133

4823. Critique of a method of treating the effect of excluded volume in polymer chains. R. J. RUBIN. *J. chem. Phys.*, **22**, 241–2 (*Feb.*, 1954).

The nature of an implicit assumption in a recent Fokker–Planck treatment of the excluded volume problem is indicated. This assumption makes the results of the treatment conditional. It is shown that if one can verify the assumption, one can dispense with the use of a Fokker–Planck equation. A.

539.133 : 535.434

Dimensions of very large molecules from light scattering in solutions. *See Abstr.* 4432

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.1

4824. Nuclear shell structure. M. H. L. PR *Rep. Progr. Phys.*, **17**, 1–34 (1954).

There is convincing evidence from the study nuclear stabilities, magnetic moments, spins and fr other sources, that there is a marked regularity nuclear properties, particularly clearly shown breaks at 2, 8, 20, 28, 50, 82 and 126 protons neutrons. This is explained in terms of an individ level model of nuclear structure similar to the mo used in explaining the periodicity of atomic struct In nuclei, a strong spin-orbit interaction, of un plained origin, plays an important part. This mo leads to an excellent understanding of nucl regularities, particularly of spins and magne moments. It has severe limitations, however, a particularly when large shells are filling, it needs to supplemented by a more "collective" approach nuclear structure. Extensive references.

539.152

4825. Local "symmetry" forces in nuclei and the derivation from the two-nucleon force. F. SCHLÖ *Z. Phys.*, **136**, *No.* 4, 441–56 (1953) *In German.*

In the Steinwedel–Jensen model [Abstr. 1231 (195 a local "symmetry" force produces dipole vibratio of the protons with respect to the neutrons in t nucleus. This is here deduced from an empiric tw body force using the Fermi gas model. The co tribution from the kinetic energy is treated as perturbation. The semi-empiric formula of Steinwed and Jensen is well confirmed both quantitatively a in that the neutron excess of heavy nuclei does n affect the model. Besides the symmetry force of t charge, there are similar forces for the spin a magnetic vibrations. Their effect on γ-emissions discussed. P. T. MATTHEW

539.152

4826. Interpretation of the virtual level of th deuteron. S. T. MA. *Rev. mod. Phys.*, **25**, 853–6 (*Oct.*, 1953).

The virtual level used to describe low-energ neutron-proton ^1S scattering may be defined, eithe by analogy with the bound ^3S level, or as the lowes ^1S resonance level. The former definition is closel associated with the S-matrix and the theory o effective range, the latter with the R-matrix. A con nected account is given of the virtual level from thes two points of view, illustrated with the use of par ticular potentials. P. T. MATTHEWS

539.152.1

4827. On a statistical model, with independent particles, of heavy nuclei. A. KIND AND G. PATERGNANI. Letter in *Nuovo Cimento*, **11**, 106–7 (*Jan.*, 1954) *In Italian.*

A refinement of a previous investigation [Abstr. 2728 (1954)] on the mean free path of nucleons in nuclear matter. It is assumed that the configuration of the nucleus is the average one given by Watanabe's method (1939); the transition probabilities are derived, as before, from the cross-sections for free nucleons. L. PINCHERLE

539.152.1

3. Symmetry properties of the Wigner 9*j* symbol. A. JAHN AND J. HOPE. *Phys. Rev.*, **93**, 318–21 (. 15, 1954).

he 72 symmetry relations of the Wigner 9*j* symbol

$$\begin{Bmatrix} j_1 j_2 j_3 \\ j_4 j_5 j_6 \\ j_7 j_8 j_9 \end{Bmatrix} = \frac{\langle (j_1 j_2) j_3, (j_4 j_5) j_6, j_9 m | (j_1 j_4) j_7, (j_2 j_5) j_8, j_9 m \rangle}{\{(2j_3+1)(2j_6+1)(2j_7+1)(2j_8+1)\}^{\frac{1}{2}}}$$

given. The group of symmetry may be generated the following elements: (i) an odd permutation of rows or columns of the symbol multiplies it by $(-1)^R$, where $R = j_1 + j_2 + j_3 + j_4 + j_5 + j_6 + j_7 + j_8 + j_9$; (ii) a reflection of the symbol in either of the diagonals leaves it invariant. These results are veniently deduced from the Schwinger generating ction for the 9*j* symbol. In an addendum a 12*j* bol is defined and some of its properties discussed. A.

539.152.1

29. Proton distribution in heavy nuclei. M. H. INSON AND E. TELLER. Letter in *Phys. Rev.*, **93**, (*Jan.* 15, 1954).

A qualitative argument shows that stability against decay requires a neutron excess at the nuclear face. P. T. MATTHEWS

539.152.1

30. The energies of excited states of nuclei. E. TAUBER AND T.-Y. WU. *Phys. Rev.*, **93**, 434–6 (*Feb.* 1, 1954).

A search for equal ratios of energies in even-even tope nuclei observed by Redlich has been extended to even-even isotone and even-odd, odd-even isotope nd isotone nuclei. It is found that on the basis of the existing data, a similar regularity does not seem to be present in these groups of nuclei. A.

539.152.1

31. Isotopic spin and odd-odd $N = Z$ nuclei. A. MOSZKOWSKI AND D. C. PEASLEE. *Phys. Rev.*, , 455–8 (*Feb.* 1, 1954).

The lowest lying states of isotopic spin $T = 0$ and $= 1$ are surveyed for odd-odd nuclei with $N = Z$ considering β-decay schemes and Coulomb energy ferences. For $A \geqslant 26$ the lowest $T = 0$ and $T = 1$ tes appear to be very close together. The analysis rmits certain predictions regarding the decay hemes of these nuclei. Further experimental formation is needed on the higher members of is series, from Sc^{42} to Cu^{58}. Predicted β-decay hemes for some corresponding $Z = N + 2$ nuclei e also summarized. A.

539.152.1

32. Tensor force and intermediate coupling in shell nuclei. T. REGGE. *Nuovo Cimento*, **11**, 285–91 (*March*, 1954).

The shell model is used to evaluate the splitting nong the levels of light nuclei with 6 or 14 nucleons. he introduced interactions are the spin-orbit uplings of every nucleon in the field of the residual ucleus, the central force and the tensor force between e external nucleons in order to calculate the influence the last one on the order and the distance of the vels. The results obtained show that at least in this particular case this influence is not negligible. Comparing these deductions with those of Inglis [Abstr. 8390 (1952)] (who used only central forces) then in the case considered the introduction of these new kinds of interactions does not lead to a better agreement with experiment. A.

539.152.1

4833. The anomalous spin of ^{47}Ti. B. H. FLOWERS. *Phil. Mag.*, **45**, 329–32 (*March*, 1954).

A general discussion is given of the occurrence of anomalous spins among the odd mass nuclei. It is shown that the spin of Ti^{47} may be understood on the basis of the independent particle model provided proper account is taken of the charge independence of nuclear forces. V^{49} is predicted to have spin 5/2. A.

539.152.1

4834. Theory of nuclear level density. C. BLOCH. *Phys. Rev.*, **93**, 1094–106 (*March* 1, 1954).

The level density of a nuclear model deduced from a statistical analysis has been compared with the results of the exact counting of the levels of the same model. The tables of levels of Ne^{20} given by Critchfield and Oleksa have been used as a test of the statistical theory. A new derivation of the level density is presented. It starts, as usual, from the independent-particle model. However, it differs from the previous treatments in two respects: (*a*) the exact states of the nucleons in the central potential are kept throughout the calculations instead of being replaced by a continuous distribution; (*b*) the effect of mutual interactions of the nucleons of the Majorana, Bartlett or Heisenberg type is taken into account in the long-range approximation. With these modifications, the statistical theory agrees very well with the exact counting of the levels, both for the total density and for the density of the levels having a given angular momentum. It is shown that the replacement of the nucleon states by a continuous distribution introduced in most previous derivations, and the neglect of the Majorana forces can produce very large errors. An interpretation is presented of the distribution of angular momentum among nuclear levels in terms of rotations of the whole nucleus as a rigid body. A.

539.152.1

4835. Spins of odd-odd nuclei in the *j–j* coupling model. I. A. HITCHCOCK. *Phil. Mag.*, **45**, 379–84 (*April*, 1954).

An attempt is made to justify the empirical rules for the spins of odd-odd nuclei recently proposed. It is found possible to do so for certain classes of nuclei, which happen to include nearly all those for which the experimental evidence is reliable and the rules obeyed. For one of the classes, however, it is necessary to make the approximation of assuming nuclear forces of infinite range. A.

539.152.1

4836. Spins of odd-odd nuclei in the *j–j* coupling model. II. A. HITCHCOCK. *Phil. Mag.*, **45**, 385–93 (*April*, 1954).

The spins of a number of odd-odd nuclei are calculated on the basis of the spin-orbit coupling model. The study is limited to light and medium

nuclei for which experimental data are available. The agreement between theory and experiment is generally good. No systematic rules are proposed, and it appears that no simple ones exist, except in the cases previously treated. A.

539.152.1 : 539.163

4837. The electric radiation of isomeric nuclei with odd neutron number. B. STECH. *Z. Naturforsch.*, **9a**, 1–4 (*Jan.*, 1954) *In German.*

The contribution of relativistic terms due to the motion of the neutron's magnetic moment is worked out and gives radiative transition probabilities within a factor 5 of the experiments, even for the strict single-particle model [see Abstr. 9010 (1952)].

W. J. SWIATECKI

539.152.1 : 539.165

4838. Radioactivity and the shell model. S. C. CURRAN. *Atomics* [*London*] **5**, 46–54 (*Feb.*, 1954).

A review of the assumptions made in the shell model of the nucleus is given. Ways in which information about nuclear levels can be obtained from β-ray and γ-ray spectroscopy are discussed in detail. G. E. BROWN

539.152.1 : 539.166

4839. Nuclear alignment at low temperatures. N. R. STEENBERG. *Phys. Rev.*, **93**, 678–81 (*Feb.* 15, 1954).

The population distribution of nuclei aligned at low temperatures is derived by means of an expansion of the density matrix in powers of A/kT with an arbitrary external field. It is shown how this is related to the angular distribution of emitted γ-radiation. The influence of interionic exchange and dipole coupling is examined to order $(A/kT)^3$ and is found to be generally small and cannot account for some experimental results. The case of finite crystal field interaction is considered as it applies to the angular distribution. A.

539.152.1 : 539.172.13

4840. Level densities of nuclei from the inelastic scattering of 18-MeV protons. P. C. GUGELOT. *Phys. Rev.*, **93**, 425–33 (*Feb.* 1, 1954).

The spectra of protons inelastically scattered from Al, Fe, Ni, Cu, Ag, Sn, Pt and Au have been measured. The energy distribution of the scattered protons is represented only approximately by a Maxwellian distribution. The relative level densities of the target nuclei have been calculated from the proton spectra. The scattering cross-sections are compared with the predictions of the statistical model. The results indicate that the observed energy variation of the level densities may not depend on the excitation energy of the residual nucleus primarily, but, instead, there is some evidence that it is a function of the energy of the emitted particle. A.

539.152.1 : 539.172.13

4841. Energy levels in N^{14} from the scattering of protons by C^{13}. E. A. MILNE. *Phys. Rev.*, **93**, 762–7 (*Feb.* 15, 1954).

The differential cross-section for the elastic scattering of protons by C^{13} has been determined in the energy range from 0·45 to 1·60 MeV at angles of 50, 90, 120, 140 and 160 degrees in the centre-of-mass system. Marked anomalies were found in the scattering at 0·55, 1·16, 1·47 and 1·55 MeV corresponding to excited states in N^{14} at 8·06, 8·62, 8· and 8·98 MeV. The spins and parities of th states have been determined from a preliminar analysis of the data which also indicates an effect d to the broad resonance at 1·25 MeV in $C^{13}(p,\gamma)$ corresponding to an excited state in N^{14} at 8·70 Me The assignment for the 8·06 MeV level is $J=1$ for the 8·62 MeV level $J=0^+$ and for the bro 8·70 MeV level $J=0^-$. The probable assignme for the 8·90 MeV level is $J=3^-$ and for t 8·98 MeV level $J=1^+$. The elastic scattering protons by C^{12} was also measured from 300 keV 550 keV at angles of every ten degrees in the centre-mass system from 30 to 160 degrees.

539.152.1 : 539.1

4842. Hyperfine structure and nuclear electr quadrupole moment of boron 11. G. WESSEL. Lett in *Phys. Rev.*, **92**, 1581–2 (*Dec.* 15, 1953).

Atomic beam resonance experiments are used find the hyperfine structure of the $^2P_{1/2}$ ground sta and the $^2P_{3/2}$ metastable state of B^{11} atoms. The fc observed frequencies are self-consistent and a interpreted to give a quadrupole moment $Q(B^{11}) = (0{\cdot}0355 \pm 0{\cdot}0002) \times 10^{-24}$ cm^2. D. H. WHIFFI

539.152.2 : 548

4843. Nuclear quadrupole resonance. H. DEHMELT. *Amer. J. Phys.*, **22**, 110–19 (*March*, 195

Nuclear quadrupole resonance is a recent developed branch of radiofrequency spectrosco which is concerned with magnetic resonance abso tion in crystals. This absorption is due to reorient tion of the non-spherical atomic nuclei again crystalline electric fields. Related phenomena isolated molecules are briefly mentioned, and this followed by an elementary treatment of the electr static interaction of a non-spherical nucleus with axially symmetric inhomogeneous electric field as found approximately in crystalline Cl_2, a cryst whose structural units are very nearly undisturbed C molecules. Electrostatic torques are shown to ex which cause a precession of the nuclear angul momenta around the molecular axes. As this moti is accompanied by a precession of the magnetic an electric moments of the nuclei, which may intera with alternating electromagnetic fields, this leads ov to the transition mechanism between the ener levels which are obtained from the correspondi Hamiltonian. Transition and power absorptio phenomena are discussed in some detail. Effec which either lead to a broadening of the absorptio lines or are connected with the thermal agitation i the crystalline lattice are treated. Some experiment aspects are described and examples of observe absorption lines are given, and all nuclei so fa investigated with this method are reviewed in thre tables. The nuclear information obtainable fro such experiments is pointed out. A

539.152.

4844. The quadrupole moment of the gold nucleu Au^{197}_{79}. W. v. SIEMENS. *Ann. Phys.* [*Leipzig*] 1 *No.* 1–5, 158–64 (1953) *In German.*

The h.f.s. of 3 lines obtained with a Fabry–Perc interferometer gave the splitting factors of th term $5d^96s^{2\,2}D_{3/2}$ from which $Q = +(0{\cdot}56 \pm 0{\cdot}1) \times$

^{24} cm². The nuclear magnetic moment $\mu = (4 \pm 0{\cdot}02)$ n.m. W. J. SWIATECKI

539.152.2

5. The magnetic moments, quadrupole moments excited states of several light nuclei. R. SCHULTEN. *Naturforsch.*, **8a**, 759–75 (*Dec.*, 1953) *In German.*

The wavefunctions of the nuclei of the 2*P* shell are esented by the energetically most favourable ture of all approximate wavefunctions, which can constructed with the required general properties n those of the one particle model, assuming an illator potential and spin-orbit coupling. The gnetic and quadrupole moments, and several ited states are then calculated. The results are in sonable agreement with experiment, and indicate ermediate coupling. P. T. MATTHEWS

539.152.2

16. Effect of the phenomenon of semi-rotation on drupole resonance. Y. AYANT, M. BUYLE-BODIN D F. LURÇAT. *C.R. Acad. Sci.* [*Paris*] **237**, 1511–13 ec. 9, 1953) *In French.*

Semi-rotations, in which the lifetime of each position τ, affect the quadrupole resonance at frequency ν_Q. If $\tau \gg 1/\nu_Q$ the resonance is broadened by $\simeq 1/(2\pi\tau)$; (ii) if $\tau \ll 1/\nu_Q$ the frequency is ected and $\delta\nu \simeq 2\pi\tau\nu_Q^2$ and is normally too weak observe. Type (i) broadening accounts for the appearance of the $CHCl_3$ resonance observed at 196°c as the temperature is raised to −183°c.

D. H. WHIFFEN

539.152.2

47. Nuclear quadrupole resonance of Hg^{201}. H. G. HMELT, H. G. ROBINSON AND W. GORDY. *Phys. v.*, **93**, 480–2 (*Feb.* 1, 1954).

Five nuclear quadrupole resonance lines have been served in polycrystalline $HgCl_2$. From their frencies, the magnitudes of the quadrupole coupling nstants $eQq_{zz}(Hg^{201}) = 720$ Mc/s and $eQq_{zz}(Cl^{35}) =$ ·3 Mc/s were evaluated. Comparison of the Cl^{35} upling constants in $HgCl_2$ with that known for the e Cl atom from atomic beam experiments facilitates e discussion of the molecular structure. A quadrule coupling constant of 1000 Mc/s per *p* electron in e 6*s*6*p* configuration of free Hg is deduced from the g^{201} coupling in $HgCl_2$. This value can be directly mpared with the coupling of the 6*s*6*p*, $^2P_2$ HgI term, $eQq_{zz}(Hg^{201}, p_z) = 780$ Mc/s, which is equivalent to e value of the quadrupole parameter $B = 0{\cdot}27 \times 10^{-3}$ cm^{-1} known from optical h.f.s. investigations. Whereas a standard analysis of the h.f.s. of the $^2P_2$ rm had given $Q(Hg^{201}) = 0{\cdot}5 \times 10^{-24}$ cm², a discrepant value $Q(Hg^{201}) = 0{\cdot}2 \times 10^{-24}$ cm² was obtained from the $^1P_1$ term. The results yield a value 6×10^{-24} cm², in fair agreement with the larger alue for for the $^2P_2$ term. A.

539.152.2 : 538.222

48. The principle of nuclear induction. F. BLOCH. *cience*, **118**, 425–30 (*Oct.* 16, 1953).

An exposition for non-specialists, including the istory and a brief description of apparatus. 17 refs.

539.152.2 : 538.222

49. Research in nuclear magnetism. E. M. URCELL. *Science*, **118**, 431–5 (*Oct.* 16, 1953).

A non-specialist survey of applications of nuclear induction methods, including measurement of nuclear magnetic moments, improvement of the accuracy of atomic constants, the study of molecular structure and motion and nuclear relaxation. 17 refs.

539.152.2 : 535.338.42

The nuclear moments of the stable iridium isotopes. *See Abstr.* 4341

539.152.2 : 538.222

Nuclear magnetic moment of ^{57}Fe. *See Abstr.* 4728

539.153

4850. The d^3 and d^4 configurations of vanadium. S. MESHKOV. *Phys. Rev.*, **93**, 270–2 (*Jan.* 15, 1954).

The term values of the d^3 configuration of V III are calculated using the experimentally observed energies of the d^4 configuration of V II. An iterative type calculation is then made for the term values of d^4 in terms of both the experimental energies of d^3 and the calculated values of the still unidentified terms of d^3. Each of these calculations leads to an appreciable improvement of the agreement between calculated and observed energies. A.

539.153

4851. The idea of cells and the geometrical significance of the idea of shells in the electron clouds of atoms. R. DAUDEL, S. ODIOT AND H. BRION. *C.R. Acad. Sci.* [*Paris*] **238**, 456–8 (*Jan.* 25, 1954) *In French.*

These ideas, previously introduced from a study of the localizability of electrons in atoms [Abstr. 1516 (1954)], are applied to the helium atom. J. HUGHES

539.153 : 535.338

4852. Relations between the low atomic configurations in the long periods. M. A. CATALAN, F. ROHRLICH AND A. G. SHENSTONE. *Proc. Roy. Soc. A*, **221**, 421–37 (*Feb.* 9, 1954).

The analysis of the spectra of the first and second *d*-electron periods is now sufficiently complete to make possible a comparison of the lowest terms of the configurations d^n, $d^{n-1}s$, $d^{n-2}s^2$ through many ionizations. The theoretical formulae in terms of the Slater parameters are available in the literature or are here deduced. It is shown that the empirical data can be used to find values of these parameters for all the elements of a period by an analysis of the relative positions of the configurations in successive elements across the period. The new values of the parameters obtained in this way are compared with published values obtained from the data on individual elements. When successive ionizations are compared, the junctions between the configurations show astonishing and unexplained regularities which are quite different in the two long periods. A.

539.153 : 535.338.332 : 530.145

Elementary particles and the Lamb–Retherford line shift. *See Abstr.* 4162

539.153 : 538.222

Magnetic resonance on optically oriented atoms. *See Abstr.* 4730

539.153.4

4853. Photo-ionization of complex atoms. L. A. VAĬNSHTEĬN AND B. M. YAVORSKIĬ. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 813–16 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-112.

Approximate continuum radial wavefunctions, which are convenient for calculation, are given. With

the radial functions for valence electrons given earlier [Abstr. 3283 (1954)] these can be used to compute photo-ionization and recombination cross-sections, formulae for which are given. For atoms with a small number of valence electrons the agreement with computations based on Hartree–Fock wavefunctions is satisfactory. G. E. BROWN

539.153.4

4854. Separation of angle variables for helium. T. A. S. JACKSON. *Proc. Cambridge Phil. Soc.*, **50**, *Pt* 2, 298–304 (1954).

The Schrödinger equation of the helium atom is separable between the radial and angular variables. The separated equations in the radial variables are found by using a new technique of calculation with symmetric traceless tensors. Account is taken of reflection and permutation characters. A.

539.153.4

4855. One-parameter approximate wavefunctions for the 2*s* states of He I. G. MUNSCHY AND P. PLUVINAGE. Letter in *J. Phys. Radium*, **15**, 122–3 (*Feb.*, 1954) *In French.*

A previous method [Abstr. 780 (1952)] is extended to excited states of 2-electron atoms. The trial functions are symmetrized hydrogen-like wavefunctions multiplied by a collision-type wavefunction for 2 electrons in the absence of the nucleus. The energy of collision is chosen so that the total energy becomes a minimum. Results are $-2{\cdot}142$ and $-2{\cdot}149$ for the energy (in atomic units) of states 2^1S and 2^3S as against experimental values of $2{\cdot}146$ and $2{\cdot}175$. F. ANSBACHER

539.153.4

4856. A discussion of analytic and Hartree-Fock wave functions for $1s^2$ configurations from H^- to C v. L. C. GREEN, M. M. MULDER, M. N. LEWIS AND J. W. WOLL, JR. *Phys. Rev.*, **93**, 757–61 (*Feb.* 15, 1954).

Two simple analytic expressions are presented, both of which are excellent approximations to a Hartree–Fock 1*s* wavefunction in a $1s^2$ configuration. One of these expressions is a two-parameter function and the other a three-parameter one. The parameters were chosen variationally and their values are given for the various members of the isoelectronic sequence from H^- to C v. The energies were also computed, and the energies and the wavefunctions are compared with the corresponding Hartree–Fock quantities where the latter are known. Both the two- and the three-parameter functions approximate the numerical functions closely and give energies as low, or almost as low, as the more reliable of the Hartree–Fock energies. The three-parameter wavefunction proves to be the better, particularly in the case of H^-. Some comments are made on the existing numerical functions and their energies. A.

539.153.4 : 535.343.1

4857. Continuous absorption by the hydrogen molecular ion. R. A. BUCKINGHAM, S. REID AND R. SPENCE. *Monthly Not. Roy. Astron. Soc.*, **112**, *No.* 4, 382–6 (1952).

A quantal calculation of the continuous absorption by H_2^+ ions in the transition from the bound $(1s\sigma^2\Sigma_g^+)$ state to the free $(2p\sigma^2\Sigma_u^+)$ state has been carried out for temperatures of 2500°K and Comparison with the results of a semi-class approximation by Bates shows substantial agreem

539.155.2 : 5

4858. Geophysical interpretation of natural isot variations of chemical elements. J. M. LOPEZ AZCONA. *Rev. Cienc. apl.*, **7**, 193–202 (*May–J* 1953) *In Spanish.*

A list is given and discussed in detail of the elem whose isotopic composition may be related to physical causes. L. PINCHE

539.1

4859. The doublet $C^{12}H$–C^{13}. H. EWALD. Not *Z. Naturforsch.*, **8a**, 447 (*July*, 1953) *In German.*

A mass-spectrographic redetermination gave the mass difference $4{\cdot}49_6 \pm 0{\cdot}01_0 \times 10^{-3}$ m.u. is in essential agreement with the value obtained f nuclear reaction data, and leads to a value $13{\cdot}00745_2 \pm 0{\cdot}00001_5$ m.u., for the mass of C^{13}. J. HUG

RADIOACTIVITY . α-, β- AND γ-RAYS 539

539

4860. Measurement of the rate of loss of tritium from tritium sources adsorbed on zirconium. J. CAMERON. *Atomic Energy Res. Establ.* [*Harw Mem. I/M* 29, 5 *pp.* (1953).

Measurements have been made using a meth flow proportional counter type 1077B of the rate loss of tritium gas from tritium sources produced Harwell. For the 30 mC source used in the exp ment it was found that there was a daily loss $1{\cdot}2\ \mu$C. This means that half of the source will lost in 49 years.

539.16 : 614.8

4861. An isotope handling calculator. R. WH *Atomic Energy Res. Establ.* [*Harwell*] *Rep. I/R* 10 4 *pp.* (1953).

The report describes a calculator which at a sin setting interrelates the following values: sou strength, γ-dose rate, distance from source a screening by lead. Direct reading values are gi for the isotopes: Na^{24}, Co^{60}, Ra or Rn, Ta^{182}, Ir Au^{198}, I^{131}.

539.16

4862. Refinements in radioactive standardization 4π beta counting. W. B. MANN AND H. H. SELIG *J. Res. Nat. Bur. Stand.*, **50**, 197–200 (*April*, 1953).

The corrections due to backscattering and f absorption for radioactive sources in 4π proportion flow counters have been investigated. The low-fi effect arising from the use of thin, but non-conducti Formvar-polystyrene films has also been investigat and the results compared with those obtained experiments carried out with such supporting fil rendered conducting by the evaporation thereon an approximately 15 μg.cm^{-2} layer of gold. San wiches of such conducting films have been used determine the absorption due to the supporti

1. It has been shown that the simpler non-con-ting source-mounting film technique may still be 1 to calibrate radioactive sources to within the ts of accuracy currently in demand. A.

539.16.08

3. **The use of plastic for the preparation of ctors, absorbers and standards.** G. GUEBEN AND OVAERTS. *Bull. Soc. Roy. Sci. Liège*, **22**, 437–43 v., 1953) *In French*.

A method of incorporating powdered materials in xiglas disks is described. This is shown to give ioactive standards (U_3O_8), thermal neutron orbers (B_2O_3) and detectors (Dy_2O_3) which are roducible and simply prepared. M. A. GRACE

539.16.08

4. **A new technique for measuring the activity compounds labelled by soft β-ray emitters.** J. C. UCAYROL AND E. OBERHAUSEN. *C.R. Acad. Sci. [Paris]* **237**, 1680–2 (*Dec.* 21, 1953) *In French*.

The labelled materials are dissolved in a scintillating uid and the scintillations detected by a photo-ltiplier-electrometer tetrode system provided with npensation for multiplier dark current and voltage ctuations. Activities of 10^{-3} μcurie are detectable l the system shows a stable linear response.

G. F. J. GARLICK

539.16.08

5. **Determination of the proportion of meso-rium, radium and radiothorium in a commercial sothorium ampoule.** I. CURIE. *J. Phys. Radium*, , 1–6 (*Jan.*, 1954) *In French*.

The MTh, Ra and RTh content of a sealed ampoule y be determined by analysis of the γ-ray pulse-ight spectrum from a scintillation counter. The ncentration of Ra and RTh in MTh may be easured to 10%. M. A. GRACE

539.16.08

6. **A low-level radon counting system.** G. L. TE, H. L. VOLCHOK AND J. L. KULP. *Rev. sci. strum.*, **25**, 153–7 (*Feb.*, 1954).

A stable, convenient system for low-level counting radon is described. The system permits a precision ±1% with an efficiency of about 80%. The lower it of measurement is the amount of radon in uilibrium with about 10^{-14} gram of radium. A rating reed electrometer is used to amplify slow ulses obtained from an ionization chamber operated 300 V. The cumulative pulse count is recorded by mechanical register following amplification of the tput of the electrometer. Special care in construc-on and selection of the ion chamber materials rmits an α-background as low as 15 counts/hr for a litre volume. Chemical pretreatment of the gases is necessary for most samples. A.

539.163

7. **Long-range particles emitted from polonium urces.** M. ADER. Letter in *J. Phys. Radium*, **15**,) (*Jan.*, 1954) *In French*.

None of the known (α, p) reactions can account r the very long range particles observed in nuclear search emulsions when exposed to polonium sources ee Abstr. 4552 (1952)]. It is suggested that they ay be emitted from the polonium nucleus itself, but the frequency of emission being so small that they can only be observed using nuclear emulsions.

A. C. COATES

539.163

4868. New radioactive nuclides of the rare earths. T. H. HANDLEY AND E. L. OLSON. *Phys. Rev.*, **93**, 524–6 (*Feb.* 1, 1954).

Proton bombardment of pure Er_2O_3, followed by ion-exchange separation, has yielded an unreported radionuclide of erbium with a 3·6 hr half-life. It is assigned to Er^{161} and decays by K capture with γ-rays of 0·195, 0·824 and 1·12 MeV energy. Its daughter, 2·5 hr Ho^{161}, was also identified and was observed to decay by K capture with a 0·090 MeV γ-ray. A.

539.163

4869. The decay of ^{203}Pb and the energy levels of ^{203}Tl. J. R. PRESCOTT. *Proc. Phys. Soc.* [*London*] *A*, **67**, 254–64 (*March*, 1954).

The electron-capture decay of Pb^{203} was studied with a scintillation spectrometer using coincidence techniques. γ-rays of energy 280 ± 5, 400 ± 7 and 685 ± 10 keV are found in the approximate proportions 1 : 0·047 : 0·0087. The whole of the spectrum is in coincidence with the X-rays following electron capture and the 280 and 400 keV γ-rays are in coincidence. A level scheme with shell model configurations is suggested for Tl^{203}; it is: ground, $s_{1/2}$; 280 keV, $d_{3/2}$; 685 keV, $d_{5/2}$. The angular correlation between the 280 and 400 keV γ-rays is discussed in relation to the published internal conversion data on the 280 keV γ-ray. Evidence is presented that part of the decay goes by L-capture. There is no appreciable electron capture to the ground state of Tl^{203}—this enables the shell model assignment $f_{5/2}$ to be made to the ground state of Pb^{203}. A.

539.163 : 532.51

4870. Hydrodynamic models of radioactive decay. H. P. KNAUSS. *Amer. J. Phys.*, **22**, 130–1 (*March*, 1954).

The flow of water through a capillary from a vessel with vertical walls is shown to simulate the decay of a radioactive sample if the velocity of efflux is low. The rate of flow, when both inertia and viscosity play a part, is worked out under simplifying assumptions. A.

539.163.1

4871. The half-life of lanthanum-140. H. W. KIRBY AND M. L. SALUTSKY. *Phys. Rev.*, **93**, 1051–2 (*March* 1, 1954).

Carrier-free lanthanum-140 was separated from barium-140 by a double barium nitrate precipitation from 80% nitric acid, using inert barium carrier. The half-life, determined by β-counting, was found to be 40·224 ± 0·020 hours over a period of 574 hours. A.

539.163.1 : 536.6

4872. Calorimetric determination of the half-life of polonium. D. C. GINNINGS, A. F. BALL AND D. T. VIER. *J. Res. Nat. Bur. Stand.*, **50**, 75–9 (*Feb.*, 1953).

The heats of radioactivity of four samples of polonium were measured with a Bunsen ice calorimeter over a period of about 7 months. With samples

ranging in initial powers from 0·17 to 1·4 W, the half-life values calculated from these measurements were found to agree within 0·1%, or the equivalent of 0·0003 W, whichever was the larger. The results with the sample with the largest power gave a half-life value of 138·39 days, with an uncertainty of 0·1% (0·14 day). This is in agreement with the value of 138·3 days (±0·1%) reported by Beamer and Easton, who used a different calorimetric method. A.

539.163.2

4873. Short-lived neutron-deficient isotopes of rhodium and palladium. A. H. W. Aten, Jr and T. de Vries-Hamerling. Letter in *Physica*, **19**, 1200 (*Dec.*, 1953).

Ruthenium was irradiated with 52 MeV He^{2+} ions: measurements on the various separated fractions indicated a Rh isotope of ½-life 9 min (β^+, $E_{max} = 4·0 \pm 0·5$ MeV) produced from a Pd isotope of ½-life 15 ± 3 min: both isotopes probably have $A = 98$, or perhaps 96. A. O. STANESBY

539.163.2

4874. On the radioactivity of Rb^{87}. J. Flinta and S. Eklund. *Ark. Fys.*, **7**, *Paper* 32, 401–11 (1954).

The radioactive radiation from Rb^{87} has been investigated, and the maximum energy of the β-spectrum found to be 250 ± 25 keV, by means of absorption in aluminium. The absorption curve shows an excess of low-energy β-particles, in agreement with the assumption that the β-decay is triply forbidden. No γ or X radiations were found. The mean value found for the total β-radiation from rubidium was 42·2 ± 0·7 β-decays per min per mg Rb, corresponding to a half-life of $(6·1 \pm 0·2) \times 10^{10}$ years for Rb^{87}. A.

539.163.2

4875. Decay of Cu^{60} and nuclear levels in Ni^{60}. R. van Lieshout, R. H. Nussbaum, G. J. Nijgh and A. H. Wapstra. Letter in *Phys. Rev.*, **93**, 255–6 (*Jan.* 1, 1954).

The β- and γ-spectra of Cu^{60} and Co^{60} were investigated using a magnetic lens β-spectrometer and single-channel scintillation γ-spectrometer; a new decay scheme is put forward. A. O. STANESBY

539.163.2

4876. Spins and parities of energy levels in Pb^{208}. L. G. Elliott, R. L. Graham, J. Walker and J. L. Wolfson. Letter in *Phys. Rev.*, **93**, 356 (*Jan.* 15, 1954).

Measurements of internal conversion coefficients and γ-γ angular correlations lead to the following assignments (assuming ground-state 0^+): 3·71 MeV level, 5^-; 3·47 MeV level, 4^-; 3·20 MeV level, 5^-; 2·61 MeV level, 3^-. The 3·20 MeV level has a half-life of $(2·4 \pm 1·0) \times 10^{-10}$ sec. J. J. WILKINS

539.163.2

4877. A new titanium nuclide: Ti^{44}. R. A. Sharp and R. M. Diamond. Letter in *Phys. Rev.*, **93**, 358 (*Jan.* 15, 1954).

Bombardment of highly purified Sc_2O_3 with 30–45 MeV protons yields a 2·7 ± 0·7 yr activity, decaying by electron capture and a 0·16 ± 0·06 MeV γ-ray (~1/disintegration) to 4 hr Sc^{44}, identified by its 1·16 MeV γ-ray. M. A. GRACE

539.16

4878. Energy levels in Lu^{176} and Hf^{176}. J. Arnold. *Phys. Rev.*, **93**, 743–5 (*Feb.* 15, 1954).

The energies of the 3 γ-rays in cascade with β^--emission of Lu^{176} have been determined to 306, 203 and 89 keV. Peak intensity and conversi X-rays suggest the assignment of all transitions *E*2. The energies support the theory of Bohr a Mottelson. The total *K* X-ray intensity shows excess to be ascribed to a *K*-capture branch setting limit of $K/\beta^- < 0·1$. The half-life of Lu^{176} $(2·15 \pm 0·10) \times 10^{10}$ years.

539.16

4879. The radioactive isotopes Al^{24}, P^{28}, C S. W. Breckon, A. Henrikson, W. M. Martin a J. S. Foster. *Canad. J. Phys.*, **32**, 223–37 (*Mar* 1954).

The positron emitters P^{28} (0·29 ± 0·01 sec) a Cl^{32} (0·32 ± 0·01 sec) have been discovered in (p, reactions with thresholds at 15·4 ± 0·6 MeV a 14·5 ± 0·6 MeV respectively. Identification realized through threshold and transition energi as well as through the complex γ-ray spectra identifi in part with the known levels of the daughters S and S^{32}. The new nuclei represent an extension the series $A = 4k$, $Z = 2k + 1$, whose initial me bers, B^8, N^{12}, Na^{20}, are delayed α-emitters, while t recently reported Al^{24} is known to emit delay alphas or protons. Under re-examination of Al^{24} half-life of 2·0 ± 0·1 sec is obtained for γ-r activity which identifies the stable daughter Mg The results are in substantial agreement with t recent work of Glass, Jensen and Richards Delayed α-particles are not observed with the n isotopes.

539.163

4880. The half-life of yttrium-90. A. Chetha Strode, Jr and E. M. Kinderman. *Phys. Rev.*, 9 1029–30 (*March* 1, 1954).

Radioactive yttrium-90 separated from two ag samples of fission product strontium was allowed decay. The change in activity was followed for mo than 650 hours with standard mica-window be counters. From the observed changes, the mea half-life of yttrium-90 was calculated to be 64·60 0·43 hours.

539.163

4881. An isomeric state of Ga^{65}. B. Craseman *Phys. Rev.*, **93**, 1034–5 (*March* 1, 1954).

A positron activity of 8·0 ± 0·5 minutes half-li has been assigned to an isomeric state of Ga^{65} on t basis of chemical separation, cross bombardments an excitation curves. Gamma-rays of 52 ± 2, 92 ± 4 an 114 ± 4 keV were measured, which exhibited t 15-minute half-life of the previously known activit of Ga^{65}. No 8-minute γ-ray was found.

539.163

4882. Radiation from antimony 122. J. M. Cor M. K. Brice, G. D. Hickman and L. C. Schmi *Phys. Rev.*, **93**, 1059–61 (*March* 1, 1954).

Neutron capture in enriched Sb^{121} yields radioacti Sb^{122} whose half-life is found to be 66·0 ± 0·4 hr. I addition to the two previously observed γ-ray present studies with scintillation and conversio

ron spectrometers indicate the existence of six iously unreported γ's. The energies are 95, 553, 616, 647, 649, 1100, 1200 keV with possibly ething at 1·9 MeV. K/L intensity ratios for the version lines are observed only for the 553 and keV γ's. The high-energy lines are observed with the scintillation spectrometer. The β-spec- is resolved into components with maximum gies at 2·00 ± 0·03, 1·40 ± 0·02 and 0·450 MeV, possibly some other lower energy present. e γ-energies in Sb^{124} are evaluated by their version electrons as 603·6, 644 and 727 keV. A.

539.163.2

3. Radiations of 13·9-min Ce^{146} and 24·4-min ^{146}. W. BERNSTEIN, S. S. MARKOWITZ AND S. RCOFF. *Phys. Rev.*, **93**, 1073–5 (*March* 1, 1954).

The radiations of Ce^{146} and Pr^{146} fission products e investigated with a scintillation coincidence trometer. The 24·4 min Pr^{146} was shown to ay by two β-branches of maximum energy ± 0·2 MeV and 3·7 ± 0·2 MeV and of about al intensity. Gamma-rays of 455 ± 13 keV, 750 ± keV and 1490 ± 40 keV were observed; the keV γ-ray was the most intense, and the 750 keV was shown to consist of two γ-rays of about same energy. A probable decay scheme is given. 13·9 min Ce^{146} was found to emit β-rays of ± 100 keV maximum energy in coincidence with of the γ-rays. Abundant γ-rays of 110 ± 5 keV, ± 5 keV, 220 ± 10 keV, 320 ± 10 keV and weak ays of about 50 keV, about 250 keV, and 270 ± keV were observed. The relative intensities and observed γ-γ coincidences are tabulated, but the a were insufficient to determine a unique decay eme. Some of the γ-rays were partially internally verted giving rise to Pr K X-rays. A.

539.163.2

4. Electron capture in the decay of Na^{22}. SHERR AND R. H. MILLER. *Phys. Rev.*, **93**, 1076–81 (*March* 1, 1954).

The ratio of electron capture to positron emission the decay of Na^{22} to the 1·28 MeV level in Ne^{22} s been determined by a comparison of the intensities positron emission and 1·28 MeV radiation. The easurements were made with a coincidence arrange- ent employing a 4π beta counter to detect the sitrons and a scintillation counter for the γ-rays. varying the bias of a discriminator responding to e γ-spectrum, one can determine the efficiency of e 4π beta counter, and the product of this efficiency d the fraction of decays which undergo electron pture. These measurements lead to a value of 110 ± 0·006 for the ratio of electron capture to sitron emission. If one assumes that the Na^{22} cay is allowed ($\Delta J = 1$, no) the theoretical value is 1135. By a comparison of these values, an estimate n be made of the magnitude of the Fierz interference rm. Subject to the above assumption, it is found at the ratio of the axial vector and tensor coupling nstants $C_A/C_T = (-1 \pm 2)\%$. A.

539.163.2 : 539.165

5. Observations on a neutron-rich rhenium otope. A. H. W. ATEN, JR AND G. D. DE FEYFER. tter in *Physica*, **19**, 1143–4 (*Nov.*, 1953).

A β^--activity with $E_{max} = 1·8 \pm 0·2$ MeV and with a ½-life of 9·75 ± 0·5 min was obtained in the rhenium fraction from the neutron irradiation of osmium. A. O. STANESBY

539.163.2 : 539.164

4886. Natural alpha activity of neodymium. E. C. WALDRON, V. A. SCHULTZ AND T. P. KOHMAN. Letter in *Phys. Rev.*, **93**, 254–5 (*Jan.* 1, 1954).

The α-particle spectra of Nd samples of successively greater purity (obtained by fractionation on a cation exchange column) were examined using nuclear emulsions, and point to a constant and unique radiation spectrum; the energy of the α-particle group was 1·9 ± 0·1 MeV, and the ½-life of Nd^{144} was estimated as within the range $0·75–3·0 \times 10^{15}$ yr. A. O. STANESBY

539.164

4887. On the disintegration of Po^{210}. R. R. ROY AND M.-L. GOES. *C.R. Acad. Sci.* [*Paris*] **237**, 1515–17 (*Dec.* 9, 1953) *In French.*

The energy distribution of the soft electrons emitted by Po^{210} was examined using a continuously sensitive diffusion chamber. The electrons are probably produced during the α-disintegration by the process described by Migdal [*Zh. eksper. teor. Fiz.*, **11**, 207 (1941)]. A. O. STANESBY

539.164

4888. A study of the fine structure of the α-radiation of U^{234}. G. VALLADAS. *C.R. Acad. Sci.* [*Paris*] **237**, 1673–5 (*Dec.* 21, 1953) *In French.*

Pulse ionization-chamber measurements (with and without coincidences with the conversion electrons or X-radiation) determined the energy of the α_1 line as 56 ± 5 keV less than the main α_0 line, and the relative intensity as ~23/100 disintegrations. There was also evidence of a second line α_2 at ~150 keV from α_0 and with an intensity of ~3–4%. A. O. STANESBY

539.164

4889. Precise determination of the energy of α-particles emitted by thorium. G. PHILBERT, J. GÉNIN AND L. VIGNERON. *J. Phys. Radium*, **15**, 16–20 (*Jan.*, 1954) *In French.*

A detailed account is given of measurements on the range of α-particles of thorium, introduced into a nuclear plate (Ilford C.2) together with ionium and polonium: these latter were used to test a calculated range-energy relation for α-particles [Abstr. 6869 (1953)]. From 600 Th^{232} α-tracks a value of 3·990 ± 0·020 MeV for their mean energy was obtained and this together with earlier measurements on the γ-radiation [Abstr. 8435 (1952)] leads to values of 4·008 ± 0·020 and 3·933 ± 0·020 MeV for the energies of the two groups. M. A. GRACE

539.164.75

4890. Range distribution of alpha particles following the decays of Li^8 and B^8. F. C. GILBERT. *Phys. Rev.*, **93**, 499–500 (*Feb.* 1, 1954).

The range distributions of the α-particles resulting from the decays of Li^8 and B^8 nuclei in nuclear track emulsion have been determined and compared. The range distribution from the decay of Li^8 nuclei is found to be similar to that measured by previous

investigators and, within statistical error, the range distribution from the decay of B^8 nuclei is the same as that found from Li^8 nuclei. A.

539.165

4891. The influence of the electron cloud on β-decay. E. Huster. *Z. Phys.*, **136**, *No.* 3, 303–30 (1953) *In German.*

The β-spectrum of RaD, in the form of lead tetramethyl, was measured with a proportional counter. It was shown that the energy difference of the electron clouds of the initial and final nuclei was shared between the electron and the neutrino. The upper limit of the RaD β-spectrum was found to be $23 \pm 2{\cdot}5$ keV. J. HUGHES

539.165

4892. The electron spectrum of $^{234}_{91}UZ$. Ong Ping Hok and G. J. Sizoo. Letter in *Physica*, **19**, 1205–7 (*Dec.*, 1953).

The measurements were made on a double-focusing β-spectrometer of mean radius 30 cm; a table of the 34 conversion lines is given, with energies and probable γ-ray assignments; 4 components were found of the continuous β-spectrum. A preliminary decay scheme is proposed. A. O. STANESBY

539.165

4893. Proportional counter measurement of the Kr^{79} *L*-capture/*K*-capture relation. M. Langevin and P. Radvanyi. *C.R. Acad. Sci.* [*Paris*] **238**, 77–80 (*Jan.* 4, 1954) *In French.*

539.165

4894. Internal bremsstrahlung and ionization accompanying beta decay. F. Boehm and C. S. Wu. *Phys. Rev.*, **93**, 518–23 (*Feb.* 1, 1954).

Internal bremsstrahlung spectra from S^{35} and Pm^{147} have been investigated with the NaI scintillation spectrometer. Both the absolute cross-section of production and the energy distribution agree with theoretical predictions. The theoretical internal bremsstrahlung spectrum of RaE was calculated by using both the observed forbidden β-spectrum and an allowed β-distribution. No significant differences in shape were found in these two cases except in the absolute cross-section of production. The ionization accompanying β-decay was studied in the case of RaE and also in Pm^{147} by measuring the characteristic X-rays in an NaI scintillation counter as well as in a proportional counter spectrometer. Both *K* and *L* radiations were observed, and their absolute cross-sections were compared with the theoretical calculations of Migdal, Feinberg, and Levinger. Because of the approximate nature of the theoretical calculations, the agreement between the theoretical and experimental results is considered satisfactory. A.

539.165 : 539.166

4895. Beta-gamma coincidences in the UX-spectrum. E. F. de Haan, G. J. Sizoo and P. Kramer. Letter in *Physica*, **19**, 1201–4 (*Dec.*, 1953).

Using a semicircular β-spectrometer, 100, 600 and 1500 keV β-spectra, and also several conversion peaks, were detected in coincidence with γ-rays. A decay scheme is presented and discussed. J. J. WILKINS

539.165

4896. Absolute beta measurement of tritium mo layers. D. E. Beischer. *Nucleonics*, **11**, 24–7 (*D* 1953).

A method of depositing single monolayers, or st form films consisting of varying numbers of mo layers of tritium-tagged stearic acid, is described. effect of backscattering on the intensity of electr emitted from the surface is considered and high ba scattering from insulating materials such as quartz Lucite is attributed to the formation of a charged la The response of various photographic emulsio placed in contact with the monolayers, is descri and the usefulness of these tritium-tagged layers standards in autoradiography is discussed. L. R. SHEPHE

539.165

4897. Experimental techniques in beta ray spect scopy. I. C. S. Cook. *Nucleonics*, **11**, 28–31 (*D* 1953).

Methods of preparing thin uniform sources chemical deposition and thermal evaporation and production of suitable Pb and U radiators γ-ray measurements are briefly outlined. Back materials, avoidance of source charging on insulat backings, baffle systems and vacuum requirements the spectrometer chambers are discussed. L. R. SHEPHE

539.165

4898. The yield of oxidation of ferrous sulfate acid solution by high-energy cathode rays. J. Saldi and A. O. Allen. *J. chem. Phys.*, **22**, 438–42 (*Mar* 1954).

An absolute determination of the yield of t ferrous sulphate radiation dosimeter has been ma by delivering to the solution a measured charge cathode rays at known energies of 1 or 2 Me Appropriate small corrections have been made f backscattering, window absorption and bremsstra lung. The result, $G = 15{\cdot}6 \pm 0{\cdot}5$, is in comple agreement with Hochanadel's calorimetric dete mination of the yield, but disagrees by 30% with t most widely used value obtained by cavity ion chamb comparison.

539.165.08 : 535.8

4899. A beta-ray microscope. W. Kerr and H. Gomberg. *Science*, **119**, 51–5 (*Jan.* 8, 1954).

A light-optical system is described for observi and counting by photomultiplier the scintillatio produced by β-rays; the β-rays themselves are in n way focused or deviated. A high-power microsco objective is used to locate a small area on a th crystal (50 microns) of a transparent scintillato which rests on the surface of a specimen containing β-emitter. A right-angled prism is then introduce behind the objective to split the light beam, each ha falling on a photomultiplier. Coincidences betwe the two detectors are recorded, thereby reducing th background noise to negligible proportions. Coun were made from object fields of the order of 10 microns in diameter, with β-rays from Co^{60}, Tl^{20} C^{14} and Ni^{63}. V. E. COSSLET

539.166

. The triple gamma-ray cascade in Sb^{124}. I. Langer and J. W. Starner. Letter in *Phys.* , **93**, 253–4 (*Jan.* 1, 1954).

riple γ-ray coincidence measurements are consnt with the proposal of a cascade of 0·64, 0·72 0·603 MeV γ-rays [see Abstr. 7081 (1953)].

A. O. STANESBY

539.166

1. Angular correlations of gamma rays in Ta^{181}. K. McGowan. *Phys. Rev.*, **93**, 471–6 (*Feb.* 1, 4).

he directional angular correlation of three different y cascades in Ta^{181} have been measured with a delayed-coincidence scintillation spectrometer ploying NaI phosphors as detectors. An interation of the results, in combination with measured hell internal-conversion coefficients, indicates that unambiguous assignment of the angular momenta three excited states in Ta^{181} and a classification of γ-rays are possible. The spin sequences are follows: for the 132–480 keV γ-ray cascade $(E2)9/2(E2 + M1)7/2$ with δ_{480}, the square root he intensity ratio of electric quadrupole to magnetic ole radiation, equal to $-1·25$; for the 132–345 keV ay cascade $5/2(E2)9/2(E2 + M1)9/2$ with $\delta_{345} =) \pm 0·2$; and for the 345–135 keV γ-ray cascade $(E2 + M1)9/2(E2 + M1)7/2$ with $\delta_{345} = 0·95 \pm 0$ and $\delta_{135} = 0.5 \pm 0·05$. The observed angular relation functions for the 132–480 keV and 132–5 keV cascades indicate an appreciable attenuation perturbing interactions in the intermediate state of nucleus by its surroundings, even in the liquid te. For polycrystalline hafnium metal and hafnium npounds, the attenuation coefficients are smaller n the "hard core" values for a static electric adrupole interaction. A.

539.166

02. Angular correlation of the cascade γ rays m the decay of $_{84}Po^{214}$. F. Demichelis and R. alvano. *Phys. Rev.*, **93**, 526–7 (*Feb.* 1, 1954).

The angular correlation of the γ-rays accompanying decay of $_{84}Po^{214}$(RaC′) was obtained using lead sorbers to separate partly the effects due to the veral cascades involved. The results indicate that me of the γ-rays are of quadrupole character and at the excited state of $_{84}Po^{214}$(RaC′) at 0·608 MeV obably has spin 2. A.

539.166

03. Gamma rays from the proton bombardment of dium. J. W. Teener, L. W. Seagondollar and W. W. Krone. *Phys. Rev.*, **93**, 1035–8 (*March* 1, 54).

The yield of the (p, γ) capture process in Na^{23} has en studied for proton energies ranging between 0·85 d 1·70 MeV. Resonances were observed correonding to excited levels of Mg^{24} at 12·71, 12·72, ·79, 12·86, 12·90, 12·94, 12·97, 13·01, 13·02, 13·08, ·10, 13·14 and 13·32 MeV. The energies of the rays emitted from the most pronounced resonances ere measured by photographing the pulse-height ectrum obtained with a single crystal scintillation ectrometer. These experiments indicate two cometing modes of decay: the radiative cascade decay leading to the ground state of Mg^{24} and the emission of a low-energy γ-ray of energy 1·6 MeV which is attributed to the $Na^{23}(p, \alpha\gamma)Ne^{20}$ reaction. No single-step transitions to the ground state were found in the capture process. Both two- and three-step transitions are observed, but all except one of the γ-ray cascades lead to the well-known 1·37 MeV state in Mg^{24}. A.

539.166

4904. Gamma rays from Ne. B. P. Foster, G. S. Stanford and L. L. Lee, Jr. *Phys. Rev.*, **93**, 1069–72 (*March* 1, 1954).

The decay scheme of the low-lying excited states of Ne^{22} has been investigated by means of a proton γ-ray coincidence study of the $F^{19}(\alpha, p)Ne^{22}$ reaction using a NaI (Tl) γ-ray scintillation spectrometer. The excitation energies of the second and third excited states were rechecked and found to be 3·3 and 4·9 MeV respectively. The results cast considerable doubt on the existence of the previously reported level at 0·6 MeV. For the 1·28 MeV excited state a single transition to the ground state was identified. The second excited state was found to decay principally by a cascade transition through the first excited state, although a weaker crossover transition direct to the ground state was also observed. The third excited state was found to decay through transitions to both the first excited and ground states. A discussion of possible spin and parity assignments by means of the Weisskopf relations is presented. A.

539.166

4905. Gamma radiation from certain nuclear reactions. R. M. Sinclair. *Phys. Rev.*, **93**, 1082–5 (*March* 1, 1954).

The γ-radiation from five nuclear reactions has been studied with a single NaI crystal. Three new resonances in the emission of 12 MeV radiation from the reaction $F^{19}(p, \gamma)Ne^{20}$ have been found at 1092 keV, 1324 keV and 1431 keV bombarding energy. The widths are, respectively, $< 1·2$ keV, 4·0 keV, and 15·7 keV, and the cross-sections at resonance are $> 0·05$ mb, 0·081 mb, and 0·19 mb, respectively. The first resonance corresponds to one in the reaction $F^{19}(p, \alpha\gamma)O^{16}$, whereas the last two do not. All the transitions are to the 1·63 MeV level in Ne^{20} or to a nearby level. Possible values of the spin and parity of the excited levels in Ne^{20} are discussed. A search was made for γ-radiation from the bombardment of lithium by 650 keV deuterons. Upper limits for the production of 5, 6 and 7 MeV γ-rays are < 2 mb, < 1 mb, and $< 0·5$ mb, respectively. A search was made for the radiative capture of deuterons in the bombardment of deuterium, helium, and oxygen. No capture γ-rays were observed, and upper limits for the cross-section for these reactions are: D_2, $< 0·05$ μb at a deuteron energy of 1260 keV; He, $< 0·1$ mb at 1055 keV; and O_2, $< 0·5$ mb at 1100 keV. A.

539.166 : 539.172.4

4906. Gamma rays excited by the inelastic scattering of neutrons in lead, bismuth, iron, nickel, and chromium. M. A. Rothman and C. E. Mandeville. *Phys. Rev.*, **93**, 796–9 (*Feb.* 15, 1954).

Using neutrons of the *d*–D reaction at an energy of 3·9 MeV, γ-rays have been excited by the inelastic scattering process in Pb, Bi, Fe, Ni, and Cr. The

energies of the γ-rays were measured by scintillation spectrometry. A.

539.166.08 : 537.542

Cl scintillation pair spectrometer. *See Abstr.* 4638

539.166.74

4907. On the scattering of electromagnetic waves by a free electron. II. Wave mechanical theory. N. D. SENGUPTA. *Bull. Calcutta Math. Soc.*, **44**, 175–80 (*Dec.*, 1952).

For Pt I, see Abstr. 3381 (1950). The fundamental equation which gives the Debye–Compton condition for scattering, appears to be true only approximately, neglecting a second-order term in e/mc^2, and the field potential. The scattering in any direction consists of a spectrum of frequencies, which probably originates from the successive absorption of one, two or more photons by the electron. A.

539.166.74

4908. Resonant scattering of recoil-broadened gamma rays. K. ILAKOVAC AND P. B. MOON. Letter in *Phys. Rev.*, **93**, 254 (*Jan.* 1, 1954).

This was observed with the 0·98 MeV γ-rays from the decay of Zn^{63}; selective scattering by copper was obtained when the Zn^{63} was in HNO_3 solution, but not when it was in a Cu cyclotron target.

A. O. STANESBY

539.166.83

4909. Internal conversion coefficient of Ba^{137}. T. AZUMA. *J. Phys. Soc. Japan*, **9**, 1–3 (*Jan.–Feb.*, 1954).

This has been investigated with a double-coil, magnetic-lens β-ray spectrometer. The relative intensities of the internal-conversion electrons of the 663 keV γ-ray for K and L, L and M energy levels have been estimated as $4{\cdot}62 \pm 0{\cdot}18$ and $15{\cdot}0 \pm 0{\cdot}8$, respectively. The value of K/L is in accord with previous experimental values and that of L/M is presented as a new value. A.

539.166.83

4910. Examination of a small branching in the radioactivity of Kr^{79}. M. LANGEVIN AND P. RADVANYI. *C.R. Acad. Sci.* [*Paris*] **238**, 232–4 (*Jan.* 11, 1954) *In French.*

Further weak lines were found in the proportional counter spectrum of Kr^{79}, and ascribed to internal conversion effects of the 44 keV γ-ray. The number of conversion electrons from electron captures leading to the 44 keV level is $(3 \pm 1) \times 10^{-3} \times$ total K-capture intensity. A. O. STANESBY

539.166.83

4911. A new method for measuring Auger transitions. C. E. ROOS. *Phys. Rev.*, **93**, 401–5 (*Feb.* 1, 1954).

The K fluorescence yields (w_K) of eight elements: zirconium, niobium, molybdenum, rhodium, palladium, silver, cadmium, and tin were measured by a new X-ray method involving the use of a NaI–Tl scintillation counter. This counter made it possible to detect the fluorescent X-rays radiated over an effective solid angle of 2π steradians. The values of w_K are: Zr—0·645; Nb—0·713; Mo—0·714; Rh—0·779; Pd—0·782; Ag—0·814; Cd—0·819, and Sn—0·840, all with an accuracy of ±3%. These results confirm the theoretical predictions of Wen that $w_K/(1 - w_K)$ is a function of Z^4, and they ar close agreement with the theoretically predicted va of Burhop and Pincherle.

539.166

4912. Lens spectrometer study of the disintegra of $MsTh_2$. W. D. BRODIE. *Proc. Phys. Soc.* [*Lond A*, **67**, 265–72 (*March*, 1954).

Measurements were made (i) of the absolute tensities of the internal conversion lines of the 57, 97, 127 and 184 keV γ-rays of $MsTh_2$ and (ii) of absolute intensity of the associated L-Auger electr The K/L conversion ratios for the 127 and 184 transitions are respectively $0{\cdot}023 \pm 0{\cdot}005$ and Difficulties are encountered in attempting to attrib spins and parities to the two lowest excited level the RdTh nucleus.

539.166

4913. The internal conversion coefficients of N Zn^{65}, and Sc^{46}. E. F. STURCKEN, Z. O'FRIEL A. H. WEBER. *Phys. Rev.*, **93**, 1053–5 (*March* 1, 19

The theory of nuclear γ-ray yield determinat from Compton electron spectra has been recen developed by Thomas and Lauritsen for interpre tion of electron spectra from photoelectric Compton conversion processes observed with magnetic lens β-ray spectrometer. The total inter conversion coefficient (N_e/N_γ) is measured by det mining N_γ from a high-energy segment of the Compt electron spectrum observed from a thick (140-mg/cm aluminium convertor and N_e from the internal c version spectrum of the same source observed witho a radiator. The total internal conversion coefficie of two of the isotopes, Mo^{95} (parent, Nb^{95}) a Ti^{46} (parent, Sc^{46}), were also determined by the dir comparison of areas under their internal conversi and β-spectrum curves and so permitted a check the new method. The results of the two methods determination of Γ are in satisfactory agreement w each other, with other experimental values, and w the predictions of Rose's tables. The results are follows: Mo^{95} (parent, Nb^{95}) $E_\gamma = 0{\cdot}77$ MeV: the areas-under-curves method $\Gamma = (2{\cdot}05 \pm 0{\cdot}13) \times 10^{-3}$, by the thick-converter Thomas–Laurits method $\Gamma = (1{\cdot}74 \pm 0{\cdot}24) \times 10^{-3}$. Ti^{46} (pare Sc^{46}) $E_\gamma = 1{\cdot}12$ MeV; by the areas-under-curv method $\Gamma = (1{\cdot}34 \pm 0{\cdot}15) \times 10^{-4}$, by the Thoma Lauritsen method $\Gamma = (1{\cdot}00 \pm 0{\cdot}06) \times 10^{-4}$. T (parent, Sc^{46}) $E_\gamma = 0{\cdot}89$ MeV: by the areas-und curves method $\Gamma = (2{\cdot}60 \pm 0{\cdot}50) \times 10^{-4}$, by t Thomas–Lauritsen method $\Gamma = (1{\cdot}86 \pm 0{\cdot}25) \times 10^{-4}$ Cu^{65} (parent, Zn^{65}) $E_\gamma = 1{\cdot}112$ MeV; by the Thoma Lauritsen method $\Gamma = (2{\cdot}20 \pm 0{\cdot}37) \times 10^{-4}$.

539.166.8

4914. Annihilation of positrons in condensed mat rials. T. A. POND. *Phys. Rev.*, **93**, 478–9 (*Feb.* 1954).

Approximately ½% fewer positrons are found annihilate with emission of two photons in amo phous solids and benzene than do so in metals. Fus quartz shows the same effect when compared wi crystalline quartz. Assuming, with Bell and Grahar that this defect is due to triplet positronium in t amorphous materials, the mean life of triplet pos

um against three-photon annihilation in the us materials is found to be approximately that ved in gases. Addition of a free radical to the ene partially quenches the difference between benzene and metals. High-purity crystalline anium is found to be similar to crystalline quartz.

A.

539.166.835 : 537.533.79

eory of bremsstrahlung and pair production. *See r.* 4604

539.166.835 : 537.533.8

eduction of an integral in the theory of pair pro- ion. *See Abstr.* 4609

539.166.9 : 531.754

recision measurement of uniformity of materials by ma-ray transmission. *See Abstr.* 4218

539.167.3

5. On the radioactivity found in the western urb of Hiroshima after the explosion of an atomic b. F. YAMASAKI. *J. Sci. Res. Inst.* [*Tokyo*], **46,** 57 (*June*, 1952).

auritsen electroscope measurements on β-particles tted from samples of sand and mud collected after atomic bomb explosion, revealed the presence of ion products. The gross β-activity was observed decay with time as $t^{-1.31}$ over a period of 1500 days. ^{89}, Sr^{90}, Y^{91}, Zr^{95}, Nb^{95}, Ba^{140}, La^{140} and Ce^{144} acti- es were identified after chemical separations.

L. R. SHEPHERD

539.169

16. A 30 curie cobalt source for radiochemical earch. A. CHAPIRO, M. COTTIN, M. HAISSINSKY, MAGAT AND C. VERMEIL. *J. Phys. Radium*, **14,** 7–9 (*Dec.*, 1953) *In French.*

The source is mounted below floor level and raised a cable into the irradiation vessel. Protection easurements are given and it is estimated that the urce strength could be increased 100 times without nger.

F. T. FARMER

539.169

17. Radioisotopic high-potential, low-current urces. J. H. COLEMAN. *Nucleonics*, **11,** 42–5 *ec.*, 1953).

Electrical energy is generated directly by β-particles om a radioisotope, in the manner first demonstrated Moseley in 1913. In the batteries described, the source is in electrical contact with the anode, and is parated from the cathode by a solid insulator, which thin enough to allow most of the β-particles to pene- ate. Polystyrene was found to be the only suitable sulator for this purpose. Exposure of this material a 250 mC source resulted in no deterioration but nly a steady increase in resistivity over a period of ne year. A battery using 10 mC of Sr^{90}–Y^{90} gave a urrent of 40×10^{-12} A at a maximum potential of 000 V.

L. R. SHEPHERD

539.169 : 614.48

4918. Application of isotopic sources to food and rug sterilization. L. E. CREAN, P. J. ISAACS, G. J. VEISS AND F. FAHNOE. *Nucleonics*, **11,** 32–7 (*Dec.*, 953).

The use of fission-product γ-sources for steriliza- ion purposes is examined. Consideration is given o dose distribution in the irradiated materials, strength and specific activity of sources required and problems of cooling sources. The deinfestation of grain with a 25 000 rep dose, by a multiple unit of rod sources, is examined by way of example.

L. R. SHEPHERD

NUCLEAR REACTIONS 539.17

539.17 : 519.281.2

On simplifying the reduction by least squares of angular distribution experiments in nuclear physics. *See Abstr.* 4095

539.172 : 530.145

4919. On external (diffractive) production of particles in nuclear reactions. I. YA. POMERANCHUK AND E. L. FEĬNBERG. *Dokl. Akad. Nauk SSSR*, **93,** *No.* 3, 439–41 (1953) *In Russian.*

In high-energy ($E > 10^9$ eV) diffractive scattering of nucleons by nuclei, nuclear recoil can become large enough to enable the nucleus to emit a γ-ray or μ-meson. The effective region in which this production occurs can lie outside the nucleus for energies of the incident particle $E > A^{1/3}Mc^2$, where A = atomic number and M = mass of incident nucleon. An order-of-magnitude estimate of the cross-section for this external production is given.

G. E. BROWN

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 4683–8

539.172

4920. Inelastic scattering of 220-MeV π^- mesons in emulsions. W. F. FRY. *Phys. Rev.*, **93,** 845–7 (*Feb.* 15, 1954).

The nuclear interaction of 220 MeV negative π-mesons has been studied in photographic emulsions. A particular type of inelastic scattering events has been analysed. Among 1960 π^--meson interactions, 17 events are observed where the π-meson transferred a large fraction of its initial energy to a single proton. The incident π-meson, the scattered π-meson, and the proton are nearly coplanar in most of these cases. However, the three tracks are not exactly coplanar indicating that the meson collision was not with a hydrogen nucleus. The 17 events are interpreted as the interaction of the incident π-meson with a single proton of the target nucleus.

A.

539.172

4921. High-energy protons in nuclear interaction of 220-MeV π^- mesons in nuclear emulsions. G. TAKEDA. *Phys. Rev.*, **93,** 848–50 (*Feb.* 15, 1954).

The inelastic scattering of 220 MeV pions by a single collision with a nucleon in a nucleus is treated on the basis of the experimental pion-nucleon cross-section. It is found possible to account in this way for the qualitative features of the events described in the preceding abstract, if the effect of absorption of scattered pions and nucleons in the nucleus is included.

A.

539.172

4922. Interaction of pions with complex nuclei. D. H. STORK. *Phys. Rev.*, **93,** 868–80 (*Feb.* 15, 1954).

Attenuation cross-sections and cross-sections for

scattering into a fixed angular interval have been measured in a well-defined geometry for pions of energies 33, 46 and 68 MeV. The targets were beryllium, carbon, aluminium and copper. The results were analysed by means of the optical model, and a strong energy dependence was found for the pion interaction mean free path in nuclear matter. A satisfactory representation of this energy dependence is the equation $\lambda_a/r_0 = [2b(kr_0)^4/\gamma^2]^{-1}$, where λ_a is the mean free path, r_0 is the pion Compton wavelength, b is a constant, k is the pion number, and γ is the total pion energy divided by its rest energy. The results of an optical model calculation with the above energy dependence were compared with other published pion-nucleus data and agreement was found. A partial wave analysis gave essentially the same results but required mean free paths about twice as long. Published values of the pion-nucleon phase shifts at several energies were used to calculate the mean free path by means of multiple-scattering theory. The results agree with the above energy dependence and are intermediate between the mean free paths of the optical model and those of the partial wave analysis. A.

539.172

4923. Electrodisintegration of Cu^{63}, Zn^{64}, Ag^{109}, and Ta^{181}. K. L. Brown and R. Wilson. *Phys. Rev.*, **93**, 443–52 (*Feb.* 1, 1954).

The ratio of the (γ, n) photodisintegration cross-section to the $(e, e'n)$ electrodisintegration cross-section for the isotopes Cu^{63}, Zn^{64}, Ag^{109} and Ta^{181} was measured for electron energies of 24 to 35 MeV. This ratio was found to decrease with energy in contrast with the Weizsäcker–Williams approximation which predicts a constant ratio. However, the Weizsäcker–Williams method does yield a result which is of the right order of magnitude for Cu, Zn and Ag and which is within a factor of two of the observed value of Ta. Assuming approximately one-half of the total photon absorption of nuclei to be attributed to the (γ, n) reaction, then comparison of the experimental results for Cu, Zn and Ag with calculations of Blair is consistent with the suggestion of Bethe and Levinger that the main absorption mechanism of nuclei for photons is electric dipole with a contribution of $\sim 6\%$ electric quadrupole absorption. However, for Ta no simple correlation between experiment and theory was found. This is attributed to a failure of the Born approximation used in the Blair calculations. A.

539.172.11

4924. Coulomb excitation of levels in ^{19}F by alpha-particles. G. A. Jones and D. H. Wilkinson. Letter in *Phil. Mag.*, **45**, 230–3 (*Feb.*, 1953).

Coulomb excitation has been demonstrated by the bombardment of a light nucleus by α-particles. Two previously known levels are located more precisely, and their possible spins and parities are discussed.

P. T. MATTHEWS

539.172.11

4925. Elastic scattering of alpha particles by neon. E. Goldberg, W. Haeberli, A. I. Galonsky and R. A. Douglas. *Phys. Rev.*, **93**, 799–805 (*Feb.* 15, 1954).

Differential cross-sections have been measured at four angles for α-energies from 2 to 4 MeV. Absolute values of the cross-section are good to ±4%. The angles chosen correspond to centre-of-mass angles such as to simplify assignments of angular momentum to the scattered resonance wave. Because no nuclear spins are involved, the angular momentum of the scattered wave also fixes the parity and angular momentum of the compound state. Thirteen resonances were observed. Eleven are attributed to virtual states of Mg^{24} and two are assigned to virtual states of Mg^{26}. The experimental data were analysed in terms of the Wigner–Eisenbud formalism to determine the additional level parameters: E_r, γ_λ^2 and Δ_λ. The laboratory energies of the $(Ne^{20} + \alpha)$ resonances in MeV, and the total angular momentum and parity assignments of the virtual states are: 2·488 (1^-), 2·573 (0^+), 2·652 (2^+), 2·903 (0^+), 3·062 (1^-), 3·184 (2^+), 3·548 (3^-), 3·780 (1^-), 3·801 (2^+), 3·839 (4^+) and 3·923 (2^+). Similarly, the assignments for $(Ne^{22} + \alpha)$ resonances are 3·245 (3^-) and 3·41 (3^-). The resonances above 3·0 MeV bombarding energy were investigated for competing reactions. No competing reaction with cross-sections greater than about 1% of the elastic value were observed. A.

539.172.1

4926. Proton-gamma angular correlations and gamma-ray angular distributions in the $^{10}B(\alpha, p\gamma)^{13}C$ reaction. A. G. Stanley. *Phil. Mag.*, **45**, 430–40 (*April*, 1954).

The angular distributions of the high-energy γ-rays (a mixture of 3·7 and 3·9 MeV γ-rays) and of the low-energy γ-rays (0·2 MeV) from the $B^{10}(\alpha, p\gamma)C^{13}$ reaction, and the angular correlations of the high-energy γ-rays with the emitted protons have been measured at five α-particle resonances at 1·13, 1·51, 1·64, 1·68 and 1·83 MeV. These experiments confirm the assignment of spins and parities 4^-, 3^- and 4^+ to excited levels of N^{14} at 12·42, 12·69 and 12·78 MeV, and spins and parities $3/2^-$ and $5/2^+$ to excited levels of C^{13} at 3·68 and 3·89 MeV. A.

539.172.13

4927. Experimental studies of (p, t) reactions. B. L. Cohen and T. H. Handley. *Phys. Rev.*, **93**, 514–17 (*Feb.* 1, 1954).

Several (p, t) reactions in heavy nuclei are studied by measuring excitation functions and angular distributions. While the data are not sufficiently extensive to justify general conclusions, they seem to indicate that: (1) a "pick-up" process is important only when the target nucleus contains two loosely bound neutrons; and (2) the inherent probability for the emission of tritons in the break-up of a compound nucleus is not much (if any) less than for the emission of neutrons or protons. A.

539.172.13

4928. Inelastic scattering of protons by Li^7. F. Mozer, W. A. Fowler and C. C. Lauritsen. *Phys. Rev.*, **93**, 829–30 (*Feb.* 15, 1954).

The absolute differential cross-section for the inelastic scattering of protons by Li^7 has been measured at ten scattering angles for incident proton energies near the 1030 keV resonance. The differential cross-section is nearly isotropic at the resonance whereas at higher energies the scattering shows marked fore-and-aft asymmetry, being predominantly

the backwards direction. The total cross-section for inelastic scattering is $41 \cdot 6 \pm 3 \cdot 0$ millibarns at an incident proton energy, $E_1 = 1050$ keV; $35 \cdot 4 \pm 1 \cdot 8$ millibarns at $E_1 = 1140$ keV; and $32 \cdot 0 \pm 2 \cdot 7$ millibarns at $E_1 = 1240$ keV. A.

539.172.13

4929. The inelastic scattering of 31-MeV protons from heavy elements. R. M. Eisberg and G. Igo. *Phys. Rev.*, **93**, 1039–50 (*March* 1, 1954).

Energy distributions, angular distributions and total cross-sections for the inelastic scattering of 31 MeV protons from four heavy elements, Pb, Au, Ta and Sn have been measured. Information was obtained at five scattering angles: 30°, 45°, 60°, 90° and 135°. The energy distributions do not show the Maxwellian-like behaviour which would be predicted on the basis of compound nucleus theory. The differential cross-sections are strongly peaked forward, increasing by about a factor of ten as the scattering angle goes from 135° to 30°. The total cross-sections all have values ranging from 0·25 barns for Sn, to 0·29 barns for Pb. A model has been proposed which is capable of giving a qualitative explanation of the results of the experiment. According to the model, the inelastic scattering occurs when the incident proton collides with the rim of a target nucleus. A.

539.172.13

4930. Special mechanisms in the reaction ^{7}Li $(p,\gamma)^8$Be. D. H. Wilkinson. *Phil. Mag.*, **45**, 259–76 (*March*, 1954).

The course of the reaction $Li^7(p, \gamma)Be^8$ is an unusual one: above the strong resonance at $E_p = 440$ keV the cross-section shows a background that, apart from weak resonances, increases steadily with increasing proton energy until at least $E_p = 5 \cdot 2$ MeV. It is suggested that this background has two origins: at the lower values of E_p it is due to direct radiative transitions between a free proton state and a bound state of Be^8—no compound nucleus is formed; at the higher values of E_p it is due to a process inverse to the familiar "giant resonances" of photodisintegration. The first contribution is calculated for a variety of conditions in LS and in *jj* coupling; the second is deduced from the known properties of neighbouring photodisintegration cross-sections. The two processes together give a good account of the experimental results; there is some suggestion that the "radius" of Be^8 may be about $3 \cdot 2 \times 10^{-13}$ cm. A.

539.172.13

4931. Resonance capture of protons by Mg^{25}. W. E. Taylor, L. N. Russell and J. N. Cooper. *Phys. Rev.*, **93**, 1056–9 (*March* 1, 1953).

Protons from a Van de Graaff generator have been used to bombard targets of Mg^{25}. The reaction $Mg^{25}(p, \gamma)Al^{26}(\beta^+)Mg^{26}$ has been studied by observing the positron yield as a function of proton energy in the region between 300 and 1200 keV. Resonance peaks occur for protons with energies of 388, 494, 510, 563, 588, 650, 683, 722, 777, 812, 880, 928, 986, 1043, 1081, 1098, 1132 and 1197 keV. The cross-section is of the order of 10^{-27} cm^2 for the stronger resonances. A.

539.172.13

4932. Isolation and measurement of the helium-4, helium-3 and tritium produced in steel by 340 MeV proton bombardment. G. R. Martin, S. J. Thomson, G. Wardle and K. I. Mayne. *Phil. Mag.*, **45**, 410–12 (*April*, 1954).

The small amounts of He^4, He^3 and H^3 produced in a block of steel bombarded with 340 MeV protons have been isolated. Measurements have been made of the total helium by a gas-volumetric method, of the tritium by counting of the associated β-particles, and of the $He^3 : He^4$ ratio by mass-spectrometry. The ratio $He^4 : He^3 : H^3$ has been found to be $1 \cdot 00 : 0 \cdot 048 : 0 \cdot 078$; this result is discussed in the light of Le Couteur's theory of nuclear evaporation. A.

539.172.13 : 539.172.4

4933. Inelastic scattering of protons and neutrons by deuterons. R. M. Frank and J. L. Gammel. *Phys. Rev.*, **93**, 463–70 (*Feb.* 1, 1954).

If it is assumed that the range of nuclear forces is small compared to the size of the deuteron and the wavelength of the incoming particle ("zero-range" approximation) and something like the impulse approximation is used, a connection between the cross-sections for elastic and inelastic *p–d* or *n–d* scattering is derived. The results of this simple theory are compared with available experimental data, and the agreement between the two is much better than the crude assumptions of the theory merit. An interesting consequence of the theory is that the connection between the elastic and inelastic scattering cross-sections is independent of the properties of the two-body forces. The elastic scattering cross-section depends hardly at all on the exchange properties of the two-body *n–p* potential (provided it gives the binding energy of the deuteron correctly) and the *n–n* potential, and the connection suggests that the same is true of the inelastic scattering cross-section. This is in disagreement with more elaborate calculations of Bransden and Burhop. A.

539.172.13

4934. Deuteron stripping reaction. S. Yoshida. *Progr. theor. Phys.*, **10**, 1–10 (*July*, 1953).

On the same assumption as Butler, deuteron stripping cross-sections are obtained in terms of the nuclear widths in the single level formula. By using this expression the reduced widths are computed from the experimental data. A.

539.172.13

4935. On the polarization in (d, p) and (d, n) reactions. J. Horowitz and A. M. L. Messiah. Letter in *J. Phys. Radium*, **14**, 731–2 (*Dec.*, 1953) *In French.*

Using the authors' stripping theory [Abstr. 3840 (1954)] the polarization is worked out assuming the interaction between the *p* and the target nucleus to be represented by an average potential. Some special cases when only one *J* contributes are given graphically. W. J. Swiatecki

539.172.13

4936. Angular distributions and yield of the reaction $^{14}N(d, p)^{15}N$. H. M. Jongerius, F. P. G. Valckx and P. M. Endt. *Physica*, **20**, 29–35 (*Jan.*, 1954).

Angular distributions were measured of the $N^{14}(d, p)N^{15}$ ground-state transition by nuclear emulsion technique at deuteron energies of 0·4, 0·5 and

0·6 MeV. There is reasonable agreement with Butler's stripping theory for $l_n = 1$. The target was prepared by bombarding an aluminium foil with 200 keV nitrogen ions. The relative yield of this reaction was measured for deuteron energies between 0·25 and 0·675 MeV using a thin-crystal NaI (Tl) scintillation spectrometer for detection of protons emitted at $\theta = 0°$ with the deuteron beam. The absolute yield at $E_d = 0·5$ MeV was also measured by a scintillation spectrometer. In this case a target was used prepared by sandwiching a thin nylon film of known thickness between two aluminium layers. A.

539.172.13

4937. Cross sections for the reactions D (d, p)T, D $(d, n)$$He^3$, T $(d, n)$$He^4$, and He^3 $(d, p)$$He^4$ below 120 keV. W. R. Arnold, J. A. Phillips, G. A. Sawyer, E. J. Stovall, Jr and J. L. Tuck. *Phys. Rev.*, **93**, 483–97 (*Feb.* 1, 1954).

These cross-sections were measured by the process of passing a deuteron beam into a thin gas target contained behind a thin window of evaporated silicon monoxide. The energy loss in the window was measured by a deceleration technique. Charged particles from the reactions were observed at 90° in the laboratory system with proportional counters. Some results are as follows: for the reaction D (d, p)T, by use of the angular distribution reported by Wenzel and Whaling, the total cross-section σ is 15·4 mb with a probable error of 3·2% at 100 keV incident deuteron energy; $\sigma = 0·629$ mb $\pm$ 5% at 25 keV. For the reaction $D(d, n)He^3$, $\sigma = 15·2$ mb $\pm$ 3·2% at 100 keV; $\sigma = 0·592$ mb $\pm$ 5% at 25 keV. The sum of these two cross-sections follows a Gamow function below 50 keV. For the reaction $T(d, n)He^4$, isotropy in the centre-of-mass system being assumed, σ shows a peak value of 4·95 barns $\pm$ 2·8% at 107 keV; at 40 keV, $\sigma = 0·72$ barn $\pm$ 3·2%; at 19 keV, $\sigma = 0·045$ barn $\pm$ 5%; below 19 keV, σ follows a Gamow function. For the reaction $He^3(d, p)He^4$ with isotropy assumed, $\sigma = 16$ mb $\pm$ 3% at 93 keV; $\sigma = 0·124$ mb $\pm$ 5% at 36 keV; and σ follows a Gamow relation below 100 keV. A.

539.172.13

4938. Angular distribution of protons from the reaction $B^{10}(d, p)$ B^{11}. W. W. Pratt. *Phys. Rev.*, **93**, 816–17 (*Feb.* 15, 1954).

The angular distributions of the four longest-range proton groups have been measured in the forward direction using a nuclear plate scattering chamber. The deuteron energy was 3·03 MeV. The observed angular distributions were not in agreement with stripping theory, indicating a relatively large contribution from compound nuclear formation. A.

539.172.13

4939. Absolute magnitudes of (d, p) scattering cross sections. G. Abraham. *Proc. Phys. Soc.* [*London*] *A*, **67**, 273–5 (*March*, 1954).

A formula is given for the absolute magnitudes of (d, p) reactions on the basis of the single particle model (square-well potential) of the nucleus and the Butler stripping theory. On comparison with experimental data for the reaction $Si^{28}(d, p)Si^{29}$ it is seen to give cross-sections which are too large, but there is reasonable agreement on relative values. This is consistent with the recent work on absolute magnitudes of Horowitz and Messiah and of Thomas. The stripping cross-section given here leads to a simple single particle formula for the reduced width, which is approximately the same as the Wigner sum-rule limit for resonance reduced widths. A.

539.172.13 : 539.152.1

4940. Interaction between D^2 and He^3 in the neighborhood of the 18·6-MeV level of Li^5. G. Freier and H. Holmgren. *Phys. Rev.*, **93**, 825–6 (*Feb.* 15, 1954).

The elastic-scattering differential cross-sections and the cross-section for the reaction $He^3(d, \alpha)H^1$ have been measured in the neighbourhood of energies corresponding to the 18·6 MeV level in the compound nucleus Li^5. The reaction data are essentially in agreement with earlier data having a maximum in the total cross-section of approximately 0·94 barn. The interference between the elastic scattering and reaction process make the elastic-scattering cross-sections at $\theta_{c.m.} = 65·4°$ about 40% less than Rutherford scattering. A.

539.172.13

4941. Reactions of U^{238} with cyclotron-produced nitrogen ions. A. Ghiorso, G. B. Rossi, B. G. Harvey and S. G. Thompson. Letter in *Phys. Rev.*, **93**, 257 (*Jan.* 1, 1954).

Bombardment of U^{238} with N^{14} ions (> 100 MeV) leads mainly to fission but small quantities of $99^{247(?)}$ (7·3 min, 7·35 MeVα), 99^{246} (? min, electron capture), Cf^{244}, Cf^{246}, $Cf^{247(?)}$ ($\sim$ 2·7 hr, electron capture), Cf^{248} (225 day, 6·26 MeVα), Bk^{243} and other Bk isotopes have been produced and identified by the order of their elution in an ion exchange column. M. A. Grace

539.172.13 : 537.534

Transmutations by N^{14} ions. *See Abstr.* 4613

539.172.3

4942. Systematics of photoneutron reactions. R. Nathans and J. Halpern. *Phys. Rev.*, **93**, 437–42 (*Feb.* 1, 1954).

Properties of the giant dipole resonances for (γ, n) reactions have been measured for 14 singly-isotopic elements distributed throughout the range of z values. Systematics are reported for the behaviour of the integrated cross-sections, the energies at which the dipole resonances attain a maximum cross-section, the values of the cross-sections at these energies, and the widths of the resonances. Anomalously narrow widths are reported for elements with neutron numbers in the vicinity of the magic numbers. A.

539.172.3

4943. Photodisintegration of the deuteron by 180-MeV and 260-MeV gamma rays. J. Keck, R. M. Littauer, G. K. O'Neill, A. M. Perry and W. M. Woodward. *Phys. Rev.*, **93**, 827–8 (*Feb.* 15, 1954).

The photodisintegration of the deuteron is observed at γ-ray energies of 180 MeV and 260 MeV. Both a low-temperature compressed-gas target and a

$-O - H_2O$ subtraction method are used. The otoprotons are detected in a crystal counter escope. Their angular distribution shows a fairly arked forward asymmetry. The total cross-sections 165 and 230 MeV (c.m.) are 54 and 66 μb, spectively, with an estimated error of 10% on the bsolute scale. A.

539.172.3

4944. Fine structure of the $F^{19}(\gamma, n)F^{18}$ activation urve. J. G. V. TAYLOR, L. B. ROBINSON AND R. N. H. HASLAM. *Canad. J. Phys.*, **32**, 238–42 (*March*, 1954). The activation curve for the reaction $F^{19}(\gamma, n)F^{18}$ as been re-examined in great detail up to an energy f 17 MeV. It shows discontinuities which are nterpreted as being due to the excitation of discrete uclear levels. The reaction cross-section is discussed n the basis of this curve. A.

539.172.4

4945. Calculation of the energy threshold of a nuclear reaction and theoretical estimates of the energies of (n_{th}, α) reactions. C. N. MARTIN. *C.R. Acad. Sci.* [*Paris*] **237**, 1671–3 (*Dec.* 21, 1953) *In French.*

The α-particle energies from thermal neutrons are predicted for favourable target nuclei with A between 20 and 85. Experimental work with heavy nuclei is suggested. J. M. CASSELS

539.172.4

4946. Total cross sections of rare earths for fast neutrons. A. OKAZAKI, S. E. DARDEN AND R. B. WALTON. *Phys. Rev.*, **93**, 461–2 (*Feb.* 1, 1954).

The total neutron cross-sections averaged over resonances have been measured for Nd, Sm, Er, Yb and Hf as functions of neutron energy from 0·06 to 3 MeV. The cross-section curves have shapes which change gradually with atomic weight and are in agreement with the values predicted by the theory of Feshbach, Porter and Weisskopf. A.

539.172.4

4947. Pulse height measurements of recoils from $B^{10}(n, \alpha)Li^7$. J. A. DE JUREN AND H. ROSENWASSER. *Phys. Rev.*, **93**, 831–5 (*Feb.* 15, 1954).

Thin films of boron deposited over a small area by vacuum evaporation have been exposed to the National Bureau of Standards thermal-neutron flux in pulse ionization chambers. Pulse ionization measurements in the past have yielded He^4-to-Li^{7*} pulse ratios considerably higher than the energy ratio of 1·753 from momentum conservation. Under suitable operating conditions ratios as low as 1·778 have been obtained. Columnar recombination appears to cause most of this variation. The probability of the reaction $B^{10}(n, \alpha)Li^7$ going to the ground state was determined to be $6{\cdot}52 \pm 0{\cdot}05\%$. A.

539.172.4

4948. Slow neutron resonances in cesium, palladium and gold. H. H. LANDON AND V. L. SAILOR. *Phys. Rev.*, **93**, 1030–3 (*March* 1, 1954).

The slow neutron total cross-sections of Cs, Pd and Au have been measured with a crystal spectrometer using beryllium as a monochromator. A strong resonance was found in Cs at 5·90 eV. The strength of this resonance is $\sigma_0\Gamma^2 = 144 \pm 25$ barn eV with $\sigma_0 = 9500 \pm 2000$ barn. Pd has a strong resonance at 34·1 eV with weaker ones at 26 and 13·3 eV. The 4·91 eV resonance in Au has been found to have unusual shape. If it is a single resonance, the maximum total cross-section is $\sigma_0 = 31\,000 \pm 1000$ barn and the total width is $\Gamma = 0{\cdot}175 \pm 0{\cdot}01$ eV. A.

539.172.4

4949. Scattering of 1-MeV neutrons by intermediate and heavy elements. M. WALT AND H. H. BARSCHALL. *Phys. Rev.*, **93**, 1062–8 (*March* 1, 1954).

Differential cross-sections for elastic scattering of 1 MeV neutrons from 28 intermediate and heavy elements were measured at intervals of 15° from 30° to 150°. The angular distributions of neutrons scattered by neighbouring elements have similar shapes, while those of elements with appreciably different atomic weight show marked differences. For all elements forward maxima were found, and elements with atomic weight below 140 exhibited additional maxima for scattering through 180°. Maxima at about 110° were observed for elements with atomic weight near 200. From the elastic scattering cross-sections, inelastic collision cross-sections and transport cross-sections were obtained. A.

539.172.4

4950. Charged particles from the interaction of 14-MeV neutrons with Li^6 and Li^7. G. M. FRYE, JR. *Phys. Rev.*, **93**, 1086–93 (*March* 1, 1954).

The angular distribution of the charged particles produced in the bombardment of Li^6 and Li^7 by 14 MeV neutrons was observed with nuclear emulsions in a multiplate camera. Metallic targets of enriched Li^6 and Li^7 were used. The following cross-sections were measured: $Li^6(n, p)He^6$, 6 ± 2 mb; $Li^6(n, d)He^5$, 89 ± 10 mb; $Li^6(n, d)He^{5*}$, 77 ± 9 mb; $Li^6(n, t)He^4$, 26 ± 4 mb; $Li^7(n, t)He^5$, 55 ± 8 mb. The reaction $Li^7(n, d)He^6$ was also observed but was not well enough resolved to give an angular distribution and total cross-section. No evidence was found for the formation of He^7 by $Li^7(n, p)He^7$ with a cross-section greater than 5 mb in the range $-1{\cdot}0 > Q > -7{\cdot}0$ MeV. The angular distributions obtained for $Li^6(n, d)He^5$ and $Li^6(n, d)He^{5*}$ indicate these reactions proceed mainly by an inverse stripping or pick-up process. The energy spectrum of the neutrons from $Li^6(n, d)He^5(n)He^4$ and $Li^6(n, d)He^{5*}(n)He^4$ is calculated using several assumptions for the angular distribution of the He^5 disintegration. A.

539.172.4

4951. A measurement of the ratio of the effective fission cross-sections for thermal neutrons of Pu^{239} and natural uranium. A. LÉVÊQUE, R. COHEN AND E. COTTON. *J. Phys. Radium*, **15**, 101–8 (*Feb.*, 1954) *In French.*

Thin layers of Pu^{239} and of natural uranium, standardized by an α-counting method, were exposed to the same neutron flux. The ratio of the fission cross-sections was found to be $205{\cdot}7 \pm 4$; comparison with other results indicates that one or other of the cross-sections probably does not obey the $1/v$ law. J. M. CASSELS

539.172.4

4952. Determination of the neutron capture cross section for the $Co^{59}(n,\gamma)Co^{60m}$ reaction. N. Moss and L. Yaffe. *Canad. J. Chem.*, **31**, 391–5 (*April*, 1953).

A determination of the neutron capture cross-section of Co^{59} leading to the excited state of Co^{60} has been made by the activation method. Samples of cobalt were irradiated in the centre of the Chalk River nuclear reactor in a pure iron capsule using a pneumatic delivery device. The cobalt activity was counted in a windowless counter and compared with the activity of a strip of pure gold irradiated under identical conditions in the same container. The cobalt and gold were counted with and without cadmium wrapping and the contribution due to epicadmium neutrons allowed for in the calculation. The mean value obtained was $18{\cdot}3 \pm 1{\cdot}7$ barns relative to $\sigma Au^{197} = 93$ barns. A.

539.172.4

4953. Distribution of prompt-neutron emission probability for the fission fragments of U^{233}. J. S. Fraser and J. C. D. Milton. *Phys. Rev.*, **93**, 818–24 (*Feb.* 15, 1954).

The kinetic energies of both members of coincident fragment pairs were measured in a double back-to-back grid ionization chamber. The pulse heights were recorded only when coincident with a prompt fast neutron detected in either one of two neutron counters placed on opposite sides of the fission chamber. The strong angular correlation of the direction of motion of the prompt fission neutrons with the direction of motion of the emitting fragment permitted the identification of the latter as the emitting fragment. The frequency distributions of modes obtained by gating with a neutron from the light or from the heavy fragment were compared with the distribution recorded without a neutron coincidence. Comparison of the three sets of data show (1) that neutron emission from the light fragment predominates at low mass-ratios, whereas at high mass-ratios neutron emission from the heavy fragment is more probable; (2) that a broad maximum in the total neutron yield exists in the region of the most probable fission mode; and (3) that the average total kinetic energy curve is essentially the same for the three conditions of measurement. A.

539.172.4

4954. Atomic energy—how it all began. O. R. Frisch. *Brit. J. appl. Phys.*, **5**, 81–4 (*March*, 1954).

A brief review of the main steps which led to the present knowledge of atomic nuclei; some remarks on how fission might have been discovered and how it actually was; various facts which decided the feasibility both of controlled and explosive chain reactions; and some personal reminiscences from the days when fission was a new toy, exciting and sometimes dangerous. A.

539.172.4

4955. On the factor of thermal utilization and the thermal diffusion length in a heterogeneous pile. S. Gallone. Letter in *Nuovo Cimento*, **10**, 1495–7 (*Oct.*, 1953) *In Italian.*

In a sufficiently simple geometry, the condition of criticality in a pile is deduced from the diffusion equations within a single cell. This pile is infinite in two directions and limited in the third by two parallel planes. F. R. Holt

539.172.4

4956. Measurements of neutron density distribution in the JEEP by copper band irradiation. M. Bogaardt, W. Hälg and J. Pelser. *JENER Rep. No.* 21, 4 *pp.* (1953).

The distributions of neutron density along various channels through the heavy water reactor JEEP was measured by observing the activation along a copper band irradiated in the channels. The 12·9 hr Cu^{63} activity was measured by means of an anthracine scintillation detector, the band being driven past the detector at a constant speed and the counting rate registered on a Brown recorder. L. R. Shepherd

539.172.4

4957. The future of heavy water reactors. L. Kowarski. *Nucleonics*, **11**, 10–14, 23 (*Dec.*, 1953).

The advantage of heavy water over graphite, as the moderator in natural uranium reactors is discussed. Modifications in the design of heavy water reactors, to make them suitable for power production, are outlined. L. R. Shepherd

539.172.4

4958. Measurement of the mean life of neutrons in a heavy water pile built with a reflector, and a novel determination of the reactivity. V. Raievski. *C.R. Acad. Sci.* [*Paris*] **237**, 1513–15 (*Dec.* 9, 1953); Erratum, **228**, 860 (*Feb.* 15, 1954) *In French.*

The measurements were made by modulating the pile at frequencies between 0·15 and 110 c/s, and determining the phase and amplitude of the neutron density oscillations. The results are discussed. J. M. Cassels

539.172.4

4959. Study of the multiplication factor in the Saclay reactor. B. Jacrot, F. Netter and V. Raievski. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 31 A–38 A (*Jan.*, 1954) *In French.*

Methods of determining the effective multiplication factor in a reactor are discussed. The theoretical relationship between this factor and the heavy water level in a cylindrical pile is set out and the observed behaviour of the Saclay reactor is shown to be in accordance with the theory. The methods are applied in determining the effectiveness of control of safety rods, the effect on reactivity of the nitrogen coolant and in the evaluation of the power level of the reactor. L. R. Shepherd

539.172.4

4960. Design and construction of water boiler neutron source. R. Chalker. *Science*, **119**, 9–15 (*Jan.* 1, 1954).

The reactor consists of an aqueous solution of uranyl nitrate contained in a one-foot spherical stainless steel tank surrounded by a graphite reflector. The intended operating power is 1 watt with a maximum neutron flux density of 4×10^6 n/cm^2 sec. The methods of disposing of fission product gases and dissociated H and O and the mixing and addition of the fissile solution to the fuel tank are described. L. R. Shepherd

539.172.4

61. The engineering design of the North American Aviation homogeneous graphite research reactor. M. STELLE. *Science*, **119**, 15–21 (*Jan.* 1, 1954).

The reactor, which is in the advanced design stage, is intended to operate at 135 kW with an available flux of 10^{12} $n/cm^2/sec$. Graphite and uranium in intimate association are sealed in an aluminium core tank. Heavy water, circulated in 70 re-entrant cooling tubes through the core, removes the heat generated. Control and safety rods are held on to rack and pinion driven carriages by means of electromagnets from which they can fall freely into the reactor if the magnets are de-energized. The close admixture of fuel and moderator in this reactor would ensure a high negative temperature coefficient.

L. R. SHEPHERD

539.172.4

962. Operation of the North American Aviation water boiler neutron source. M. E. REMLEY. *Science*, **119**, 21–8 (*Jan.* 1, 1954).

The procedure and the data obtained during the critical assembly of the reactor are described. Results of measurements on safety and control-rod effectiveness, gas evolution and flux distribution are given. The use of the water boiler for danger coefficient measurements is discussed. L. R. SHEPHERD

539.172.4 : 537.542

Ionization chamber for neutron flux measurement. *See Abstr.* 4633

539.172.4 : 669

963. Metals for reactor-core construction. H. A. WALLER. *Science*, **119**, 4–8 (*Jan.* 1, 1954).

The sources, methods of production and fabrication, and the principal properties of a number of metals are described and tabulated. The materials include uranium, thorium, beryllium and zirconium.

L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18 : 537.591

International Congress on Cosmic Radiation at Bagneres de Bigorre. *See Abstr.* 4659

539.18

4964. A discussion on *V*-particles and heavy mesons: Introduction: *V*-particles and heavy mesons. C. F. POWELL. *Proc. Roy. Soc. A*, **221**, 278–92 (*Jan.* 27, 1954).

A non-specialist review including a brief outline of the history of the discovery of the μ- and π-mesons. A glossary of the principal terms employed is given as an appendix. For papers presented in the discussion see abstracts following and Abstr. 5560, 5715 (1953).

539.18

4965. A discussion on *V*-particles and heavy mesons: Observations on the decay of heavy mesons in photographic emulsions. M. G. K. MENON AND C. O'CEALLAIGH. *Proc. Roy. Soc. A*, **221**, 292–318 (*Jan.* 27, 1954).

A detailed account is given of the measurements and interpretation of 20 examples of the decay of *K*-particles and the following conclusions are drawn: (*a*) the secondary particles produced in the decay of *K*-particles are in some cases μ-mesons and in others π-mesons; (*b*) no evidence has been obtained for the existence of electrons amongst the secondary particles but their presence cannot be excluded; (*c*) there is decisive evidence for the existence of κ-mesons which decay into a μ-meson and two or more secondary particles. The mean value obtained for the mass of the κ-meson is 1125 m_e; (*d*) there is strong evidence for the existence of a two-body decay, referred to as the χ-decay which proceeds according to the scheme $\chi^{\pm} \rightarrow \pi^{\pm} + N^0$. H. ELLIOT

539.18

4966. A discussion on *V*-particles and heavy mesons: Some slow *K*-particles, their decay at rest and production in cosmic-ray stars. A. BONETTI, R. L. SETTI, M. PANETTI AND G. TOMASINI. *Proc. Roy. Soc. A*, **221**, 318–27 (*Jan.* 27, 1954).

Describes four events which are classified as *K*-particle decays. Analysis of these events leads to the following conclusions: (*a*) the masses of the *K*-particles lie in the range 1000 to 1400 m_e; (*b*) in one case the decay product has been identified as a μ-meson of energy $\sim$70 MeV; of the other secondaries, one can be a μ-meson of $\sim$100 MeV and another a π-meson of $\sim$130 MeV; (*c*) these heavy mesons can be produced in nuclear interactions in which the energy liberated is of the order of a few GeV. H. ELLIOT

539.18

4967. A discussion on *V*-particles and heavy mesons: The decay processes of neutral *V*-mesons. K. H. BARKER. *Proc. Roy. Soc. A*, **221**, 328–38 (*Jan.* 27, 1954).

The evidence for the existence of neutral *V*-mesons, and the probable nature of their decay products, are discussed. An explanation of all the available experimental data is given in terms of two two-body decay processes. There is strong support for a V_2^0-meson decaying into two light charged mesons; if they are π-mesons the mass of the V_2^0-meson is $(964 \pm 40)m_e$. Several particles which cannot be explained in this way may be examples of the decay of a V_3^0-meson, involving the production of a light and a heavy charged meson, with a *Q*-value between 50 and 70 MeV. Some possible relationships between the V^0-mesons and the heavy charged mesons are discussed, and, in particular, it is suggested that the V_2^0-meson might be a neutral τ-meson. A.

539.18

4968. A discussion on *V*-particles and heavy mesons: *S*-particles and charged *V*-particles. C. C. BUTLER. *Proc. Roy. Soc. A*, **221**, 339–50 (*Jan.* 27, 1954).

A detailed discussion is given of the known properties of the unstable *S*-particles and charged *V*-particles, other than their lifetimes. *S*-particles are singly charged and decay at rest in thin lead plates inside a cloud chamber into one charged secondary particle and one or more neutral particles. Charged *V*-particles are also singly charged and decay in flight in the cloud-chamber gas into a charged secondary particle and one or more neutral particles. Some of

the *S*-particles are probably identical with the χ-particle, and the charged *V*-particles probably consist of a mixture of κ- and χ-particles. A.

539.18

4969. A discussion on *V*-particles and heavy mesons: Production of heavy mesons by protons of energy between 2 and 3000 GeV. R. R. Daniel and D. H. Perkins. *Proc. Roy. Soc. A*, **221**, 351–66 (*Jan.* 27, 1954).

The masses of the secondary particles emitted from disintegrations produced by cosmic-ray protons of energy greater than 2 GeV have been determined by observations on the grain density and scattering of their tracks in photographic emulsions. It has thus been possible to determine the yield of the heavy charged mesons with mass between 900 and $1400m_e$, as a function of the energy of the primary particles. Among 325 secondary particles which produce tracks with grain density between 1·07 and 2·0 times the minimum value, twenty heavy mesons have been identified. The statistical distribution in the measured values of their mass is consistent with a unique value of $1210 \pm 40m_e$. The total observed proper time of flight of these particles is $2{\cdot}9 \times 10^{-10}$ sec; no example of decay "in flight" has yet been observed. The rate of production of these heavy mesons, referred to as *K*-particles, has been compared with the frequency with which heavy mesons are observed to decay at rest; the ratio is consistent with the estimated lifetime of the *K*-particles. In the disintegrations produced by primary particles of energy greater than ~ 20 GeV, approximately equal energy goes into production of π- and *K*-particles. The yield of *K*-particles at a primary energy of 2 to 3 GeV is estimated to be a few per cent per primary interaction. The results suggest that not only π-mesons but also κ-mesons are "heavy quanta" associated with the nuclear field. If charged mesons of mass between 276 and $900m_e$ are created directly in showers, they occur with a frequency $<1\%$ of the π-particles. A.

539.18

4970. A discussion on *V*-particles and heavy mesons: A study of a disintegration produced by a particle of energy $\sim 20\,000$ GeV. J. H. Mulvey. *Proc. Roy. Soc. A*, **221**, 367–83 (*Jan.* 27, 1954).

A detailed investigation has been made of a nuclear disintegration produced by a charged particle, almost certainly a proton, of energy $\sim 20\,000$ GeV. The disintegration, of type $22 + 76p$, was recorded in a stack of plates exposed at $\sim 90\,000$ ft. The jet of secondary charged particles, and the associated cascade of electrons and photons, can be followed through the emulsion of twenty-two plates. The observations lead to a value 0·25 for the ratio of neutral π-particles to charged shower particles produced in the disintegration. If π^0-mesons are produced in high-energy nuclear interactions with a frequency half that of the charged π-mesons, and if 10% of the shower particles are assumed to be protons, the present results indicate that 40% of the charged shower particles are other than π-mesons. As there is no evidence for the existence of nucleon pairs, it is reasonable to identify these other particles with the heavy κ-particles. The corresponding ratio of the numbers of charged κ- to π-mesons, $N_{\kappa\pm}/N_{\pi\pm}$, is equal to $0{\cdot}80 \pm 0{\cdot}4$. The interaction length of th shower particles from the event, measured witho distinction between the different types of meson which may be among them, is shown to be ver nearly equal to the value for nucleons. It follows tha the κ-mesons, which constitute a large fraction of th shower particles, interact strongly with nuclei. A

539.1

4971. A discussion on *V*-particles and heavy mesons: Analysis of a τ-meson observed in a photographic emulsion exposed at 26 000 m. G. Baroni, G. Castagnoli, G. Cortini, C. Franzinetti an A. Manfredini. *Proc. Roy. Soc. A*, **221**, 384– (*Jan.* 27, 1954).

The τ-meson decayed at rest and one of th emerging π-mesons then decayed into a μ-meson i the emulsion. Detailed analysis of the event leads t a value of $978 \pm 9m_e$ for the mass of the τ and Q value of 75 ± 4 MeV. H. ELLIO

539.1

4972. A discussion on *V*-particles and heavy mesons: An example of a τ-meson generated in a nuclea encounter at high energy. M. Ceccarelli, N Dallaporta, M. Merlin, G. Quareni and G. T Zorn. *Proc. Roy. Soc. A*, **221**, 386–9 (*Jan.* 27, 1954).

The τ-meson emerged from a star of which th primary energy is estimated to be at least 30 GeV The mass of the τ is estimated to be $975 \pm 12m_e$ an the Q value to be $78{\cdot}2 \pm 4{\cdot}8$ MeV. H. ELLIO

539.1

4973. A discussion on *V*-particles and heavy mesons: The production of τ-mesons. P. E. Hodgson. *Proc Roy. Soc. A*, **221**, 389–90 (*Jan.* 27, 1954).

It is pointed out that there appears to be some evidence that τ-mesons are produced more frequently by hydrogen than by heavier elements. It is suggested that further evidence could be obtained by exposing plates at high altitude surrounded by ice or paraffin and by operating a cloud chamber first under a block of hydrogenous material and then under lead.

H. ELLIO

539.18

4974. A discussion on *V*-particles and heavy mesons: Decay of a τ-meson. W. O. Lock and J. V. Major. *Proc. Roy. Soc. A*, **221**, 391–4 (*Jan.* 27, 1954).

A τ-meson decay has been observed in an Ilford G 5 emulsion exposed under 14·5 cm of iron at an average height of 35 000 ft. Measurements made on the secondary particles suggest that they are all π-mesons. The Q-value of the decay is $(79 \pm 3{\cdot}5)$ MeV, corresponding to a mass for the τ-meson of $(983 \pm 10)m_e$. The data now available on τ-mesons are briefly discussed. A.

539.18

4975. A discussion on *V*-particles and heavy mesons: A search for nuclear disintegrations produced by slow negative heavy mesons. M. W. Friedlander, G. G. Harris and M. G. K. Menon. *Proc. Roy. Soc. A*, **221**, 394–405 (*Jan.* 27, 1954).

Describes the preliminary results of a search for evidence of the nuclear interactions of negative heavy mesons. A qualitative analysis is given of the possible characteristics of their interactions and

appearance these might be expected to have in tographic emulsions. 37 ml of emulsion, in which recorded 10 000 stars and 1200 slow π-mesons, e been completely examined. In the conditions of osure, such a volume should contain six examples, good geometry, of the decay of heavy mesons. ss measurements have been carried out, by the ge/scattering method, on 417 tracks of σ-mesons. addition, 1800 σ-mesons, observed in 42 ml of ulsion, have been examined. No disintegrations ich can be attributed to heavy mesons have been nd. The results suggest that some of the negative avy mesons, on being brought to rest in photo- phic emulsions, behave in a manner qualitatively ferent from that of negative π-particles. Possible planations for this result are suggested. A.

539.18

4976. A discussion on *V*-particles and heavy mesons: e mean lifetime and frequency of production of arged *V*-particles. J. A. NEWTH. *Proc. Roy. Soc. A*, **1**, 406–11 (*Jan.* 27, 1954).

The evidence from four cloud-chamber experiments consistent with a single value of the mean lifetime all charged *V*-particles and *S*-particles. This lue is between 4×10^{-9} and 10^{-8} sec. If the -particles are a mixture of different types of particle, is unlikely that more than 20% of them have a etime outside these limits. A.

539.18

4977. A discussion on *V*-particles and heavy mesons: -particles and χ-mesons. J. P. ASTBURY. *Proc. Roy. oc. A*, **221**, 412 (*Jan.* 27, 1954).

It is pointed out that the estimated lifetime of the τ^0_2-particle is inconsistent with the suggestion that the τ^0_2 is the neutral decay product of χ-meson. H. ELLIOT

539.18

4978. A discussion on *V*-particles and heavy mesons: he production of *V*-particles in low-energy interactions. D. D. MILLAR. *Proc. Roy. Soc. A*, **221**, 412–13 (*Jan.* 27, 1954).

Draws attention to three cloud-chamber events in which charged and neutral *V*-particles are produced n interactions of low multiplicity. H. ELLIOT

539.18

4979. A discussion on *V*-particles and heavy mesons: An attempt to detect the artificial production of V^0-particles by high-energy photons. G. BERNARDINI AND E. SEGRÉ. *Proc. Roy. Soc. A*, **221**, 413–14 (*Jan.* 27, 1954).

Gamma-rays from a betatron were allowed to fall on a hollow cylindrical aluminium target containing G5 emulsions in a lead container. No event was found which could definitely be interpreted as the decay of a *V*-particle. From the observed number of π-mesons it is concluded that the cross-section for production of *V*-particles is less than 2×10^{-4} that for π-mesons. H. ELLIOT

539.18

4980. A discussion on *V*-particles and heavy mesons: δ-ray counting as an aid to distinguishing between singly charged particles of different mass. A. D. DAINTON AND P. H. FOWLER. *Proc. Roy. Soc. A*, **221**, 414–19 (*Jan.* 27, 1954).

Observations on the δ-rays associated with the tracks of singly-charged particles can contribute to the problem of distinguishing particles of different mass. The distribution of δ-rays along tracks of protons brought to rest in photographic emulsions, has therefore been determined, and hence the relative numbers of protons, deuterons and tritons among the singly-charged particles brought to rest in emulsions exposed to cosmic radiation at high altitudes. Knowledge of the distribution of δ-rays on the tracks of low-energy protons has two applications to current investigations employing "nuclear" plates: (*a*) in the selection, for calibration purposes, of protons without an admixture of deuterons; and (*b*) in the analysis of real or suspected heavy-meson events. A.

539.18

4981. A discussion on *V*-particles and heavy mesons: Discussion on κ-mesons emerging from stars. N. DALLAPORTA. *Proc. Roy. Soc. A*, **221**, 420 (*Jan.* 27, 1954).

539.18

4982. Observation of the stopping of particles with masses of 500 to 600m_e. A. ALIKHANYAN, V. KIRILLOV-UGRYUMOV, N. SHOSTAKOVICH, V. FEDOROV AND G. MERZON. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 511–13 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-150.

Gives a preliminary account of observations on particles of mass 500–600m_e which stop in a cloud chamber containing copper plates and operated in conjunction with a magnetic spectrometer. The examples given are of positive particles which on stopping give rise to an electron pair. It is suggested that the heavy particle decays into a π^0 and a π^+-meson. The π^0-meson then decays into two photons with subsequent conversion of one of them into an electron pair. It is estimated that the lifetime of the particles cannot be much shorter than 5×10^{-9} sec. H. ELLIOT

539.18

4983. Total cross section of pions at 1·5 BeV. R. L. COOL, L. MADANSKY AND O. PICCIONI. Letter in *Phys. Rev.*, **93**, 249–50 (*Jan.* 1, 1954).

Using 2·3 BeV protons on Be and scintillation-counter attenuation measurements of the π^--beam, the cross-section for π^- on p was 34 ± 3 mb and the d-p difference 29 ± 3 mb. W. J. SWIATECKI

539.18

4984. Total cross section for positive pions in hydrogen. S. L. LEONARD AND D. H. STORK. *Phys. Rev.*, **93**, 568–74 (*Feb.* 1, 1954).

The total cross-section for positive pions in hydrogen has been measured at pion kinetic energies of 33, 44, 56 and 70 MeV. The attenuation of pions of these energies in liquid hydrogen was studied by scintillation-counter techniques. The geometry was such that pions scattered at angles greater than $\pm35°$ were counted as having been removed from the beam. Therefore, the term "total cross-section" is taken to mean the cross-section for all interactions except those in which the pion is scattered into an angle of less than $\pm35°$ from the pion-beam direction. The results are: for pion energies $33 \pm 4{\cdot}5$, 44 ± 4, 56 ± 4, 70 ± 5 MeV, the cross-sections are $6{\cdot}4 \pm 2{\cdot}1$,

$9{\cdot}8 \pm 1{\cdot}5$, $17{\cdot}6 \pm 2{\cdot}2$, $19{\cdot}0 \pm 2{\cdot}6$ mb respectively. The energy dependence of the cross-section seems to agree with the predictions of lowest-order perturbation theory for pseudoscalar mesons with gradient coupling to the nucleon. A.

539.18

4985. Disintegration into 3 π-mesons and the hypothesis of isotopic invariance. V. B. Berestetsky. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 519–21 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-135.

Under the assumption that the isotopic spin of the τ-meson is unity, the various possible (symmetrical) wavefunctions of the three decay π-mesons are discussed. If the τ-meson has an ordinary spin of zero, the three π-mesons can be formed in S states and the ratio of the probability for decay into two π^+-mesons and a π^--meson to that of decay into two π^0 and a π^+ is 4. If, however, the ordinary spin of the τ-meson is unity, two of the decay π-mesons can be formed in S states and one in a P state, and the above ratio then lies between 1 and 4. G. E. BROWN

539.18

4986. Disintegration in flight of a heavy particle. M. Ceccarelli and M. Merlin. Letter in *Nuovo Cimento*, **10**, 1207–9 (*Aug.*, 1953) *In Italian.*

It appears probable that the unstable particle had a mass larger than that of the proton and decayed to a neutron with the emission of a π-meson.

L. PINCHERLE

539.18

4987. Mean life-time of mesons in aluminium, sulfur and lead. A. G. Tenner. *Physica*, **20**, 24–8 (*Jan.*, 1954).

A new set up is described which allows the measurement of the mean lifetime of positive and negative cosmic-ray mesons in different absorbers. From the results the capture probabilities for negative mesons in aluminium and sulphur have been calculated. The results are $1/\tau_c = 0{\cdot}77 \times 10^6$ sec^{-1} for aluminium and $1{\cdot}18 \times 10^6$ sec^{-1} for sulphur. A.

539.18

4988. The average lifetime of the τ-meson. E. Fabri and B. F. Touschek. Letter in *Nuovo Cimento*, **11**, 96–7 (*Jan.*, 1954) *In Italian.*

It is possible to account for the lifetime of the τ-meson if its spin is one and its parity is odd: the behaviour of the wavefunctions of the π-mesons emitted in the disintegration is then the same as if the spin of the unstable particle were ~ 4, in which case it is known that the experimental value of the lifetime may be explained. L. PINCHERLE

539.18

4989. Observation of a new decay mode of a heavy meson. J. Crussard, M. F. Kaplon, J. Klarmann and J. H. Noon. Letter in *Phys. Rev.*, **93**, 253 (*Jan.* 1, 1954).

An event observed in stripped emulsions flown at 102 000 ft can be interpreted as $\tau^+(930 \pm 85 m_e) \rightarrow \pi^+ + 2\pi^0$; $\pi^+ \rightarrow \mu^+ + \beta^+$. Total track over 12 mm.

W. J. SWIATECKI

539.1

4990. Some observations on the decay of neutral V-particles in photographic emulsions. M. Yasin. *Phil. Mag.*, **45**, 413–17 (*April*, 1954).

In an examination of two-particle events recorded in photographic emulsions, four examples have been observed of a type similar to the decay of Λ^0-particles in Wilson chambers. In three of these the measured energy-release in the decay is ~ 40 MeV; in the fourth example it is ~ 70 MeV. An event has also been observed, which appears to correspond to the decay in flight of a θ^0-particle, emitted from a nuclear disintegration of type $10 + 7p$. One of the secondary particles arising from the decay is a negative π-meson. The measured Q-value is 202 ± 11 MeV. A.

539.1

4991. Interaction of π^+ mesons in photographic plates. I. A. Minguzzi, G. Puppi and A. Ranzi. Letter in *Nuovo Cimento*, **10**, 1753–5 (*Dec.*, 1953).

In a survey of plates exposed to 62 MeV π^- 22 (π^+, H) scatterings were identified (peak around $\theta_{lab} \simeq 120°$), leading to a cross-section of 22 ± 5 mb. Six stops in flight were found, giving ~ 5 mb for the charge-exchange process $\pi^+ + n \rightarrow p + \pi^\circ$.

W. J. SWIATECKI

539.1

4992. Observations on charged hyperons in photographic emulsions. M. W. Friedlander. *Phil. Mag.*, **45**, 418–23 (*April*, 1954).

Two examples have been observed. One decays in flight, and its transformation may be represented $Y^\pm \rightarrow L^\pm + N^0 + Q$, the release of energy, Q, being consistent with values obtained in other laboratories. In the other example, the secondary is a fast proton. This event may represent either the decay of a new type of hyperon or the nuclear capture of a negative hyperon. A.

539.18

4993. Evidence for nuclear interaction of a charged hyperon arrested in photographic emulsion. R. H. W. Johnston and C. O'Ceallaigh. *Phil. Mag.*, **45**, 424–9 (*April*, 1954).

The appearance of the interaction is that of a typical σ-star, but is caused by a particle of protonic mass. Estimates of mass by two independent techniques are in agreement with each other, and are consistent with those of charged hyperons reported by other workers. A.

539.18

4994. The mass difference of neutral and negative π mesons. W. Chinowsky and J. Steinberger. *Phys. Rev.*, **93**, 586–9 (*Feb.* 1, 1954).

The angular correlation of the decay γ-rays from neutral π-mesons produced in the reaction $\pi^- + p \rightarrow n + \pi^0$ has been measured, using counter techniques. Analysis of the observed correlation function yields a value of the $\pi^- - \pi^0$ mass difference $m_{\pi^-} - m_{\pi^0} = 8{\cdot}8 \pm 0{\cdot}6\, m_e$. A.

539.18

4995. A speculation on V-spin. D. C. Peaslee. *Progr. theor. Phys.*, **10**, 227–30 (*Aug.*, 1953).

A specific example is exhibited to show that it is necessary to assume complete pair production of V^0

particles in order to understand their copious production *v.* slow decay in isolation. This argument can be extended to V_2^0 as well as V_1^0. It also applies to the heavy "*V*-fragments" recently observed, which do not seem to be compatible with the pair-production hypothesis. The idea of *v*-spin provides a convenient though not necessarily correct vehicle for the discussion. A.

539.18

4996. On the anelasticity of the impact nucleon-nucleus at the high energies. P. BUDINI AND G. PIANI. *Nuovo Cimento*, **10**, 1288–98 (*Sept.*, 1953) *In Italian.*

A method is suggested for determining experimentally the fraction, γ, of the energy of the incident nucleon spent in the creation of mesons (anelasticity factor), based on the analysis of the absorption of the *n* component of the cosmic radiation. It is applied to data published on this absorption in C and Pb; for C, $\gamma = 0{\cdot}25 \pm 0{\cdot}10$; for Pb, γ is nearer to one. L. PINCHERLE

539.18 : 539.172.13

4997. Production of positive mesons in heavy nuclei. J. GASIOROWICZ. *Phys. Rev.*, **93**, 843–5 (*Feb.* 15, 1954).

The data on the *A* dependence of low-energy meson production by protons on heavy nuclei are explained by taking into account the following effects: (1) the energy degeneration of the incident proton in nuclear matter, which tends to make meson production possible only in the "front" of the struck nucleus; (2) the subsequent re-absorption of the meson by the nuclear matter it traverses. This last effect is further strengthened by the reflectivity of the Coulomb barrier. A.

539.18

4998. Production of heavy unstable particles by negative pions. W. B. FOWLER, R. P. SHUTT, A. M. THORNDIKE AND W. L. WHITTEMORE. *Phys. Rev.*, **93**, 861–7 (*Feb.* 15, 1954).

In addition to two previously discussed cloud-chamber examples of *V*-particle production by 1·5 GeV π^- mesons from the cosmotron, four further examples are discussed here. In two of the new examples a $\Lambda^0(V_1^0)$ and a $\theta^0(V_2^0)$ are seen to decay in a geometry indicating that they were produced together in a $\pi^- - p$ collision. A third example is best interpreted as production of a $\Lambda^-(V_1^-)$ together with a $K^+(V_2^+)$ by a π^- colliding with a proton. A fourth example shows a probable Λ^- decaying into a π^- and a neutron with a *Q* value of about 130 MeV. A cross-section of ~ 1 millibarn for *V*-particle production is inferred from the number of $\pi^- - p$ collisions observed. A.

539.18 : 530.145

4999. Second-order perturbation approximation in meson-nucleon scattering. G. P. WEBER. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 369–80 (1953) *In German.*

For charged π-mesons (pseudoscalar with pseudoscalar coupling) the second order contributions to the differential cross-sections are calculated for the limit of zero meson mass. The error introduced in this limit is estimated for the case of zero angle scattering. The total cross-section is calculated for the extreme relativistic case. G. FIELD

539.18

5000. Scattering of 151 and 188-MeV positive pions by protons. G. HOMA, G. GOLDHABER AND L. M. LEDERMAN. *Phys. Rev.*, **93**, 554–60 (*Feb.* 1, 1954).

A beam of ~ 200 MeV π^+-mesons was defined inside the vacuum chamber of the Nevis Cyclotron. Nuclear emulsions were exposed to a flux of about 10^4 mesons/cm^2. The plates were scanned for pion-hydrogen scatterings and 103 such events were observed in two interaction energies, 151 ± 7 MeV and 188 ± 8 MeV. Total cross-sections of 152 ± 31 and $159 \pm 34 \times 10^{-27}$ cm^2 are obtained respectively. The data suggest that the angular distribution changes from backwards peaked to almost symmetric over this energy interval. These observations are not in agreement with the hypothesis of a $P_{\frac{3}{2}}$-wave resonance in this energy region. The best fit to the combined results includes a *D*-wave contribution of $-5{\cdot}4°$, although satisfactory agreement may be obtained with only *S* and *P* waves. A.

539.18

5001. The scattering of 45-MeV positive pions by hydrogen. J. OREAR, J. J. LORD AND A. B. WEAVER. *Phys Rev.*, **93**, 575–7 (*Feb.* 1, 1954).

Standard Ilford G.5 plates were exposed in an improvised 46 MeV external pion beam of the Chicago cyclotron. Scatterings of the pions by the hydrogen in the emulsion were observed by scanning for recoil protons and examining the proton beginnings for an incoming and scattered pion. Energy-momentum conservation permits separation of similar looking non-hydrogen events from the pion-proton scatterings. The average pion energy in the plates was determined to be 45 ± 2 MeV from 15 events where the recoil proton stops in the emulsion. A total cross-section of (12 ± 3) millibarns has been obtained from 37 pion-proton scatterings. No scatterings were observed less than 79°. Only four are less than 90°. A phase shift analysis of the data gives $\alpha_3 = -(5{\cdot}7 \pm 1{\cdot}2)°$, $\alpha_{33} = (4{\cdot}4 \pm 1{\cdot}1)°$, and $\alpha_{31} = (2{\cdot}4 \pm 1{\cdot}8)°$. Since these particular phase shifts happen to give very little Coulomb interference, these data do not determine the absolute signs of the phase shifts. Upon comparison of these results with scattering data at other energies, α_3 appears to vary as the first power of the pion momentum and α_{33} with the third power at pion energies less than 80 MeV. A.

539.185

5002. Measurement of total cross-sections for slow neutrons. E. GATTI, E. GERMAGNOLI AND G. PERONA. *Nuovo Cimento*, **11**, 262–73 (*March*, 1954) *In Italian.*

The energy dependence of the total cross-sections for slow neutrons of uranium, nickel and cadmium were investigated with the transmission method by means of a time-of-flight spectrometer and of a pulsed neutron source. A.

539.185

5003. The calculation of the spectrum of neutrons at points in a semi infinite hydrogenous medium, whose free surface is irradiated by monoenergetic neutrons falling normally onto it. J. H. TAIT AND M. B. BIRAM. *Atomic Energy Res. Establ.* [*Harwell*] *Mem. T/M*92, 12 *pp.* (1953).

Capture is neglected and cross-sections are assumed to vary as $1/v$. A Spherical Harmonics P_1 approxima-

tion is used and a particular solution is obtained which, when modified to give the correct value and derivative at the initial velocity, is shown to give an accurate description of the spectrum. A.

539.185

5004. A determination of the energy of antimony–beryllium photoneutrons. R. Culp and B. Hamermesh. *Phys. Rev.*, **93**, 1025–8 (*March* 1, 1954).

The effective energy of Sb–Be photoneutrons has been measured by comparison of the transmission cross-sections of five elements for the photoneutrons with previously measured cross-section values over a range of energies. The result placed the energy close to 25 keV. A.

539.185 : 548.74

5005. On the scattering of slow neutrons by crystals near the Bragg angles. A. Sjölander. *Ark. Fys.*, **7**, *Paper* 29, 375–90 (1953).

Formulae for the diffuse temperature scattering of neutrons by a isotropic cubic crystal are derived, holding when the Laue interference conditions are approximately fulfilled. The singularities of the scattering cross-section are studied for anisotropic cubic crystals, and relations between the singular directions and the elastic constants of the crystal are given. Finally some general results for the intensity of the scattering are derived. A.

539.185

5006. Temperature variation of the magnetic inelastic scattering of slow neutrons. L. Van Hove. *Phys. Rev.*, **93**, 268–9 (*Jan.* 15, 1954).

The main features of the temperature variation of the magnetic inelastic scattering of slow neutrons in iron, recently measured by Palevsky and Hughes [Abstr. 3893 (1954)] are accounted for, by use of a theoretical description of the scattering in terms of the correlation between pairs of spins at different positions and different times. Proofs will be given in a later paper devoted to a general discussion of space-time correlations and of their use in scattering theory. A.

539.185

5007. The scattering of slow neutrons by ferromagnetic crystals. G. L. Squires. *Proc. Phys. Soc.* [*London*] *A*, **67**, 248–53 (*March*, 1954).

A beam of filtered neutrons with an average wavelength of 7·0 Å was used to measure the total cross-section of iron as a function of temperature from 290°K to 1170°K. The cross-section is found to have a sharp peak at the Curie temperature, 1043°K. At this temperature the measured scattering cross-section is 8·6 barns, while the calculated value of the cross-section due to nuclear scattering alone is 3·8 barns. A similar experiment carried out for nickel reveals only a slight increase in the cross-section at the Curie temperature, 631°K. At this temperature the calculated value for the nuclear scattering cross-section is 7·5 barns. The observed additional scattering is (0·11 ± 0·05) barn. A.

539.185.08

5008. Neutron scintillation counting by the $S(n, p)P^{32}$ process in ZnS(Ag) phosphors. G. R. Keepin. *Rev. sci. Instrum.*, **25**, 30–2 (*Jan.*, 1954).

Evidence is presented for neutron counting by the $S(n, p)P^{32}$ endothermic reaction in ZnS(AG) powde phosphors. Preliminary studies have been made the possible application of this reaction in sulph containing crystals to neutron scintillation spec metry above ~ 2 MeV.

539.18

5009. A fast neutron scintillator. W. S. Emmeri *Rev. sci. Instrum.*, **25**, 69–70 (*Jan.*, 1954).

A fast neutron scintillator adapted to end-wind photomultipliers is described for neutron detect above ~ 0·3 MeV energy. Light pulses are produ by the action of recoil protons from paraffin on z sulphide phosphor, the optimum weight ratio of paraffin/zinc sulphide mixture being 3:2. Interfer γ-ray pulses are suppressed by a 3 μsec time-const in the photomultiplier output circuit, and subsequ amplitude discrimination. A detection efficiency 3·8% is attained for 4·1 MeV neutrons through incorporation of ½ in. deep Lucite light guides.

539.185.08 : 614.

5010. Estimation of thermal neutron fluxes nuclear photographic emulsions loaded with lithi C. Giminez and J. Labeyrie. *J. Phys. Radium*, *Suppl. No.* 1, 38 A–44 A (*Jan*, 1954) *In French.*

Integrated fluxes between 10^6 and 5×10^8 neutro cm^2 may be measured by counting $Li^6(n, \alpha$ events. The use of the technique for health m toring is described. J. M. CAS

539.185.9 : 538.5

5011. A new method of studying certain phys chemical effects caused by irradiation in pi measuring the radio frequency absorption of so M. Duhamel, M. Freymann and R. Freyma *C.R. Acad. Sci.* [*Paris*] **237**, 1684–5 (*Dec.* 21, 1953 *French.*

From measurements on the variation of absorp in the 1–1000 kc/s range with temperature frequency, the effect of irradiation of solids, e. creation of lattice defects and consequent new en levels, can be determined. Results are quoted f ZnO specimen before and after neutron bomb ment. C. A. HOGA

STRUCTURE OF SOLIDS 539.2

539.2

5012. Physics of the glassy state. II. The t formation range. E. U. Condon. *Amer. J. P* **22**, 132–42 (*March*, 1954).

For Pt I, see Abstr. 3897 (1954). The concep fictive temperature as a means of describing equilibrium states of glass is described. Activa energies and the modern views of chemical rate cesses are discussed in relation to the kinetics o approach of these nonequilibrium states to e brium.

539

5013. The determination of the texture of sheet from torque curves. L. R. Blake. *Brit. J. Phys.*, **5**, 99–104 (*March*, 1954).

The excellent magnetic properties of cold-red silicon-iron strip are achieved by a close contr

e mechanical and heat treatments, the object of hich is to attain a high degree of preferred orientation which the plane of the sheet is a {110} crystallo-raphic plane and the direction of rolling is a ⟨100⟩ r cube edge direction. The torque curve is used xtensively to check if the ideal orientation is achieved. n this paper a rapid method of deducing the orienta-on from torque curves is proposed, applicable to the articular case of cold-reduced silicon-iron sheet. Used in conjunction with X-ray data, the method ssists the more accurate assessment of the deviation rom the ideal orientation; used alone it enables the leparture to be measured in terms of the "root mean quare angle of spread," and gives some information of the component angles of spread in different irections. The results show that the torque curve an be used with confidence as a means of control during production, and useful information of the orientation can be obtained from the curve without the need for elaborate analysis. A.

539.215 : 539.61

5014. The influence of adsorbed gases on the process of adhesion during sintering of metal powders. J. MAURER. *C.R. Acad. Sci.* [*Paris*] **238**, 86–9 (*Jan.* 4, 1954) *In French.*

Samples of Cu powder were annealed for 20 min at temperatures T between 200 and 600°C in various atmospheres and the degree of adhesion determined by measuring the load R required to drive a needle into the samples to a given depth. R increases with T at a rate which depends on the atmosphere, increasing in the order vacuum, He, Ne, N_2, A, H_2. The increased adhesion in gaseous atmospheres is attributed to an increased surface mobility of atoms.

A. D. LE CLAIRE

539.215.2

5015. Observation of the grain boundary in soap bubble raft. II. Dynamical behaviour of the grain boundary. E. FUKUSHIMA AND A. OOKAWA. *J. Phys. Soc. Japan*, **9**, 44–51 (*Jan.–Feb.*, 1954).

For Pt I, see Abstr. 799 (1954). The dynamical behaviour of the grain boundary is observed in the process of relative displacement between the two grains. Each type of grain boundary, classified into three types in respect to their statical transition structure, behaves differently. The relative displacement between two grains separated by the grain boundary of type A has the issue of shifting the array of constituent parallel dislocations normal to the boundary. The relative displacement between two grains separated by a straight boundary of type B is accommodated wholly by the independent rearrangement of the bubbles in the boundary layer of a few bubble diameters thickness. As to the grain boundary of type C, the dynamical behaviours of the constituent dislocations can be analysed into two modes. In the mode (i), rather similar to that of type A, the constituent dislocations displace themselves as a whole. In the mode (ii), rather similar to that of type B, the constituent dislocations remain stationary but frequently change their characteristic Burgers vectors, this being accompanied by local yielding in portions along the grain boundary. The statical, as well as the dynamical, behaviour in the mode (ii) of the grain boundary of type C is analogous to Mott's theory of viscous flow along the grain boundary. To interpret the mode (ii), it is proposed to introduce transient dislocations, traversing along the grain boundary and reacting with the constituent dislocations. In terms of the transient dislocations the activated state in the process of viscous flow corresponds to an intermediate stage involving transient dislocations, whence the rate of flow is determined by the energy required to decompose a constituent dislocation and activate a transient dislocation, under favourable influence of the local strain. A.

539.217

5016. Sodium diffusion in sodium tungsten bronze. J. F. SMITH AND G. C. DANIELSON. *J. chem. Phys.*, **22**, 266–9 (*Feb.*, 1954).

Diffusivity was measured in single crystals of the metallic sodium tungsten bronze, $Na_{0.78}WO_3$, at 664°C, 752°C and 832°C. Concentration gradients were established by effusion of sodium from single crystals into a vacuum and were measured by determining the variation in the lattice constant. The diffusivities were calculated by a method which is based upon Fick's first law and which, to the author's knowledge, has not been used previously. The data obtained from several crystals held at constant temperature for varying periods of time gave a family of curves showing the sodium concentration as a function of depth with time as a parameter. From these curves the mass of sodium transferred through a plane parallel to the surface and at any particular depth could be obtained; this mass was plotted as a function of time. The slope of this curve divided by the concentration gradient, both evaluated at the same time and depth, was taken as the diffusivity for the corresponding concentration. The diffusivity of sodium in $Na_{0.78}WO_3$ was found to be represented by the equation $D = D_0 \exp(-\Delta H/RT)$, where $D_0 = 0{\cdot}87$ cm²/sec and $\Delta H = 51{\cdot}8$ kcal/mol. In order to calculate the diffusivity it was necessary to determine the coefficients of linear expansion. For $Na_{0.8}Wo_3$ the length L at temperature T_c was found to be $L = L_0[1 + (8{\cdot}81 \times 10^{-6})T_c - (1{\cdot}92 \times 10^{-9})T_c^2]$, where L_0 is the length at 0°C and T_c is the temperature in degrees centigrade. A.

539.217

5017. Diffusion of gold into copper. A. B. MARTIN, R. D. JOHNSON AND F. ASARO. *J. appl. Phys.*, **25**, 364–8 (*March*, 1954).

Radioactive tracer techniques have been utilized to measure the rate of diffusion of gold into polycrystalline copper over the temperature range from 1000°C to 375°C. These experiments have yielded the values $Q = 44\,900 \pm 1300$ cal/mole and $D_0 = 0{\cdot}10 \pm 0{\cdot}06$ cm²/sec for the volume diffusion process in the temperature range from 1000°C to 750°C. Diffusion measurements at 550°C and 375°C indicated that the measured rates at these temperatures had been enhanced by grain-boundary diffusion. Considerable attention was directed toward the variation of the diffusion coefficient with (1) the purity of the copper, (2) the grain size of the copper, (3) the thickness of the plating, and (4) the time of anneal. Variations of these parameters

showed no significant effect on the diffusion coefficient, with the exception of the time of anneal. The measured diffusion rate at 1000°C was observed to decrease with increasing time of anneal. A.

539.217

5018. Diffusion of antimony in silver. E. Sonder, L. Slifkin and C. T. Tomizuka. *Phys. Rev.*, **93**, 970–2 (*March* 1, 1954).

The diffusion coefficient of antimony tracers in single crystals of pure silver has been measured as a function of temperature over the range 468–942°C. The relation $D = D_0 \exp(-H/RT)$ was found to be obeyed with $H = 38\,320$ cal/mole and $D_0 = 0{\cdot}169$ cm²/sec. These values are in marked disagreement with those appearing in the literature. The data suggest, in addition, that any variation with temperature in D_0 of the form $D_0 = D_0' T^n$ is such that n probably lies in the range 0 to $+\frac{1}{2}$. This implies that any temperature variation of H is probably less than 1 cal/mole deg. A.

539.217

5019. Effect of screening on solute diffusion in metals. D. Lazarus. *Phys. Rev.*, **93**, 973–6 (*March* 1, 1954).

A simple atomistic theory of solute diffusion in metals for cases of negligible chemical concentration gradients is discussed. Calculations are made, using a Thomas–Fermi approximation, of the influence of the presence of impurity atoms on the Fermi electrons of the lattice. The results are applied to the case of diffusion of Sb in Ag, and indicate that the screening terms are sufficient to explain the magnitude and direction of the observed deviation from self-diffusion in Ag for a vacancy mechanism for diffusion. A.

539.217 : 539.89

5020. The effect of compression and of hydrostatic pressure on the diffusion anisotropy in zinc. T. Liu and H. G. Drickamer. *J. chem. Phys.*, **22**, 312–19 (*Feb.*, 1954).

Measurements have been made on the rate of self-diffusion in single crystals of zinc along the directions both parallel and perpendicular to the *C* axis. The effects of compression by an applied force and hydrostatic pressure up to 10 000 atm on the rate of diffusion were studied. The self-diffusion coefficients of polycrystalline zinc were also measured under both atmospheric pressure and compression. The rate of self-diffusion in single crystals of zinc was found always to be larger in the direction parallel to the *C* axis, while the enthalpy of activation was found always to be smaller in this direction. Both compression and hydrostatic pressure tend to reduce the rate of self-diffusion, the greater effect being observed in the direction parallel to the *C* axis. Compression perpendicular to the direction of diffusion gave essentially the same effect as compression in the direction of diffusion. The enthalpy of activation was found to be increased 30% by the application of a pressure of 8000 atm and to be decreased slightly by compression. The anisotropy in the rate of diffusion was found to decrease with increased hydrostatic pressure. The self-diffusion coefficients of polycrystalline zinc were found to be intermediate between the values observed in the two directions (parallel and perpendicular to the *C* axis) in single crystals and to be closer in magnitude to the values observed in the direction perpendicular to the *C* axis.

539.2

5021. The mutual solubility of lead and tin in the solid state, and its variability according to the temperature. E. Kurzyniec and Z. Wojtaszek. *Bull. internat. Acad. Polon. Sci. A, No.* 3–6, 131–46 (*March–June*, 1951).

This was determined by measuring the electrical resistance of "quenched" thermally treated alloys at 0°C (R_0) and at liquid N_2 or H_2 temperatures (R_N). A sharp break occurs at the limit of solubility in the curves of R_0/R_N against composition. Solubility of Sn in Pb : 8·1 at. % at 100°C, 4·0 at 60°C and 3 at room temperature. Solubility of Pb in Sn : 1 at. % at 170°C, 0·35 at 100°C and 0·25 at room temperature. A. D. Le Clair

539.21

5022. The influence of temperature on the mutual solubility of tin and thallium in the solid state. Z. Wojtaszek. *Bull. internat. Acad. Polon. Sci. A, No.* 3–6, 147–57 (*March–June*, 1951).

Employs the method of the preceding abstract. At 140°, 100°, 60° and room temperature the solubility of Tl in Sn is respectively 0·35, 0·225, 0·175 and 0·125 at. % and of Sn in Tl, 30·4, 25·9, 21·8 and 20 at. %. A. D. Le Clair

539.219

5023. The solid solubility of metals in lead and zinc. A. Pasternak. *Bull. internat. Acad. Polon. Sci. A, No.* 3–6, 177–92 (*March–June*, 1951).

Measurements of the ratio of electrical resistivity at 0°C and at liquid H_2 or N_2 temperatures as a function of composition are used to indicate the limits of solid solubility. The specimens are quenched from some annealing temperature and it is assumed that the structure is characteristic of this quenching temperature. Results are given for the systems Ag, Cd, Mg and Zn in Pb, and Pb, Al, Bi, Cd in Zn, and from the agreement between these and published values it is concluded that the method is satisfactory.

W. M. Lomer

539.23 : 621.791.335

5024. A technique of soldering to thin metal films. R. B. Belser. *Rev. sci. Instrum.*, **25**, 180–3 (*Feb.*, 1954).

In the past, soldering to thin metal films on glass or quartz substrates has normally been accomplished by suitably reinforcing the film at the soldering point with a thicker underlying film. This performance is necessary in order to prevent tin-lead solders and commonly used fluxes from destroying the film and to give better adhesion to the substrate. It has been found that by using the metal indium and certain of its alloys as a solder, without a flux, adherence to thin metal films may be readily obtained without destruction of the film. Since indium also adheres to glass, quartz, ceramics and silicious minerals, the strength of the joint is not determined by the strength or adherence of the metal film but by the strength of the indium-glass or indium-quartz bond. Thus, films of only a few angstroms in thickness may be soldered without damage, with good mechanical strength and

ctrical contact. The strength of the bond is usually out 500 lb/in². This technique has been found ost useful in studying the resistivities of thin metal ms and in the mounting of metal-coated piezo- ectric crystals. Soldered connections have been ade to films of 18 metals including aluminium, anium and zirconium. A.

539.234

025. Preparation of thin layers on a tantalum upport. Technique relating to the obtaining of very dherent thermal deposits and the fixing by brazing of ntalum to copper. P. GARIN, P. LEGER AND P. RUGNE. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 45 A–6 A (*Jan.*, 1954) *In French.*

A thin layer of Fe or Cu is deposited by thermal vaporation *in vacuo* on the Ta support which is ndependently heated to 1550°c and its temperature lowly decreased during the evaporation to about 00°c. The deposit surface is then brazed to a Cu lock. The whole is suitable as a support for the arget in a particle accelerator. S. WEINTROUB

539.234 : 539.218

5026. Apparent density of thin evaporated films. M. S. BLOIS, JR AND L. M. RIESER, JR. *J. appl. Phys.*, **25**, 338–40 (*March*, 1954).

Measurements of the apparent densities of copper and silver films formed by evaporation are described. The interpretation of the results and the manifestations of low apparent densities in physical experiments are discussed. Measurements indicate that the apparent density of both the copper films and the silver films is about 7 g/cm³ at an average thickness of about 300 Å. A.

539.26 : 539.374

5027. X-ray investigation of internal strains in plastically deformed iron. E. KAPPLER AND L. REIMER. *Z. angew. Phys.*, **5**, *No.* 11, 401–6 (1953) *In German.*

Internal strains in iron are measured by back-reflection X-ray techniques. Different radiations and angles of incidence are used. The observed variation of the internal strain with angle of incidence is compared with that calculated by an extension of the theory due to Greenough [Abstr. 4255 (1949)]. The general agreement is good but the observed strains are 7–8 times greater than those calculated, and this discrepancy is attributed to work-hardening of the crystallites. A. E. DE BARR

539.27

5028. Kinematic structure investigation with electron beams. A. BOETTCHER AND R. THUN. *Optik*, **11**, *No.* 1, 22–31 (1954) *In German.*

By arranging the photographic plate of an electron diffraction camera to move continuously beneath a narrow slit aperture, changes in the structure of the specimen under examination may be investigated by the changes in its diffraction pattern. The slit aperture allows the undeflected beam and small arcs of the diffraction patterns to be recorded, and the camera incorporates a heating stage for the specimen. The method has application in the study of diffusion processes, corrosion and heat treatment of alloys. Phase diagrams can be built up by scanning an alloy specimen of continuously varying proportions, with synchronized movement of the plate. Fine structure in alloys can similarly be investigated.

A.E.I. RESEARCH LABORATORY

539.27

5029. A replica process for the electron microscope. R. BERNARD AND S. BERNARD. *C.R. Acad. Sci.* [*Paris*] **238**, 222–4 (*Jan.* 11, 1954) *In French.*

A variation of the methyl methacrylate/silica technique is described, in which the methacrylate is flowed on the surface to be replicated as a solution. A syrupy solution of methacrylate in trichlorethylene is used, which dries to form a film sufficiently thick to be stripped mechanically. Silica is then evaporated on in the normal way, and the methacrylate dissolved away. A.E.I. RESEARCH LABORATORY

539.27

5030. A simple silica replica method. Cathodic sputtering as a means of treating surfaces to be examined. C. FERT AND R. DARGENT. *C.R. Acad. Sci.* [*Paris*] **238**, 662–4 (*Feb.* 8, 1954) *In French.*

A direct replica method, using evaporated silica with subsequent collodion backing, is described. Cellulose tape is used for stripping. The advantages of the cathodic sputtering method of treating surfaces, compared with that of chemical attack, are summarized. A.E.I. RESEARCH LABORATORY

539.27 : 771.533

5031. An evaporated carbon replica technique for use with the electron microscope and its application to the study of photographic grains. D. E. BRADLEY. *Brit. J. appl. Phys.*, **5**, 96–8 (*March*, 1954).

A method for the production of carbon replicas by evaporation on to the specimen is described. The specimen is subsequently removed by solution. The method has been applied to the examination of photographic grains, which could not be resolved in the optical microscope or observed directly in the electron microscope. A resolution better than 100 Å is obtained. A.

539.27

5032. Bombardment of an object by ions while under observation by electron diffraction and by electron reflection microscopy. C. FERT. *C.R. Acad. Sci.* [*Paris*] **238**, 333–5 (*Jan.* 18, 1954) *In French.*

A simple ion gun, utilizing an accelerating voltage of 25 kV, and capable of bombarding the surface of the specimen in an electron microscope or diffraction camera, is described. Ionic bombardment serves to decharge insulating specimens, and also can be used to remove the surface layers of a reflection specimen in a controllable manner. This latter is illustrated by reflection diffraction patterns of a mechanically polished single crystal of copper, showing successive removal of the polish layers.

A.E.I. RESEARCH LABORATORY

539.27 : 539.234

5033. Sudden changes in the arrangement of crystallites in thin evaporated bismuth films. L. L. HOWARD. Letter in *J. appl. Phys.*, **25**, 125–7 (*Jan.*, 1954).

Photographs are given which show how a sudden change in the arrangement of crystallites occurs when the beam of an electron microscope impinges on a

thin film of Bi. The reason for the "tilting" of the crystallites is not clear. C. A. HOGARTH

539.27 : 537.533.3

5034. An electron diffraction apparatus with a new electron optical system designed for the examination of surface structure. C. S. LEES. *J. sci. Instrum.*, **31**, 84–6 (*March*, 1954).

A new electron optical system is used for diffraction work, particularly on surface structure. A strictly parallel beam is used at the specimen, obtained by means of a collimating lens placed before the specimen; the diffracted beams are then focused by means of a second lens, of large aperture, placed immediately after the specimen. The half-rings obtained are accurately in focus, and in order to improve the accuracy of measurement the specimen holder is arranged to permit the specimen to be turned over to the other side of the beam so that a second exposure gives half-rings diametrically opposite to the first exposure. Measurements can then be made across diameters. Provision is also made for incorporating a calibrating exposure. A.

539.27 : 539.219

5035. Application of electron microdiffraction to the study of phase transformation in Al–Cu alloys. N. TAKAHASHI AND C. FERT. *C.R. Acad. Sci.* [*Paris*] **237**, 1664–6 (*Dec.* 21, 1953) *In French.*

Phase transformations in Al–Cu alloys were followed by examination of their diffraction patterns in a three-stage electron microscope, operated as a micro-diffraction camera. The changes took place by diffusion of the metals into one another on heating a composite evaporated layer of the two metals. Using excess copper, the transformation from Cu–Al to Cu_9Al_4 was studied. A.E.I. RESEARCH LABORATORY

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31

5036. The fundamental integral of the anisotropic elasticity differential equation. E. KRÖNER. *Z. Phys.*, **136**, *No.* 4, 402–10 (1953) *In German.*

A general treatment of the problem shows that in hexagonal-type crystals the displacements due to a point force (in the absence of body forces), can be expressed in terms of one elementary function, analogous to the potential function in the solution of Laplace's equation. Under conditions of cylindrical symmetry it reduces to a function introduced by Love. In crystals of other symmetry, no such elementary representation is possible. A Fourier representation is possible, and an approximate development of the Fourier transform in spherical harmonics is given. W. M. LOMER

539.31

5037. The viscoelasticity of linear polymeric substance. S. HAYASHI. *J. Phys. Soc. Japan*, **9**, 56–8 (*Jan.–Feb.*, 1954).

The viscoelasticity of highpolymeric substance is discussed from the standpoint of a molecular theory. The strain of a substance consists of the polym elongation and the intermolecular slipping. The two kinds of strain and the polymer elongation a called the macroscopic elongation and the microscop elongation respectively. Supposing the rate of t intermolecular slipping obeys the Eyring formula t relation between the macroscopic elongation-factor and the microscopic elongation-factor α is obtain from $d\lambda/dt = d\alpha/dt + Ab\varepsilon(\alpha - 1)$, where A, b a ε are physical constants. Solving this equation t following results are obtained: (1) at constant stra the retractive force decays exponentially against tim as expected; (2) when the velocity of elongation constant the retractive force shows a maximu against the elongation and decays gradually elongation goes on. A

539.31 : 534.01 : 532.51 : 530.14

The application of Fourier transforms in physica problems. *See Abstr.* 4157

539.31 : 539.6

5038. Low-temperature internal friction and elasticit effects in vitreous silica. M. E. FINE, H. VAN DUYN AND N. T. KENNEY. *J. appl. Phys.*, **25**, 402–5 (*March* 1954).

Near 35°K the internal friction of vitreous silic reaches a peak value which increases with frequency The temperature curves of the torsion and Young' moduli are concave upward with minima near 65°K and are independent of frequency. These effects ar reversible with temperature. The cause cannot b the usual type of relaxation process or anything involving diffusion or large amounts of shear. A

539.312

5039. Relation between stress-relaxation studies and dynamic properties of polyisobutylene. E. CATSIFF AND A. V. TOBOLSKY. *J. appl. Phys.*, **25**, 145–52 (*Feb.* 1954).

Experimental results on stress-relaxation modulus $E_r(t)$ and complex dynamic modulus $E'(\omega) + iE''(\omega)$ of polyisobutylene are now available in the literature. To cover the entire time scale, the effect of changing the temperature of measurement is assumed to be equivalent to a linear change of the time scale. According to the general theory of linear viscoelastic behaviour, the functions E_r, E' and E'' can each be computed from any one of them. This is qualitatively correct. The data on E' in the transition region can be represented by the Gauss Error Integral form of equation used by Bischoff, Catsiff and Tobolsky for E_r of several polymers. The "wedge-box" distribution function proposed by Tobolsky is also compared with the experimental data and shows a reasonably good agreement with experimental results over the entire time scale. A.

539.312

5040. Experimental study of low-frequency effects on the dynamic modulus of a Buna-N rubber. A. Q. HUTTON AND A. W. NOLLE. *J. appl. Phys.*, **25**, 350–3 (*March*, 1954).

The linear dynamic Young's modulus of a vulcanized Buna-N gum rubber is measured at frequencies of 0·05, 0·10 and 1·00 c/s, in the temperature range −22°C to 30°C, by a method in which a small

ferential sinusoidal elongation is superimposed on 5% static elongation. The width of the dispersion nge on the temperature scale (the range in which logarithm of the modulus increases steeply with creasing temperature) is only about 10°C, as contrasted with widths as great as 25°C found in previous easurements on a similar compound at frequencies several kc/s. The modulus-temperature plot shifts ward by only about 4°C per decade of frequency crease in the present range, as contrasted with out 10°C per decade in the previous measurements higher frequencies. It is concluded that this astomer cannot be described properly by means of e "method of reduced variables," in which the ynamic properties are ascribed to mechanisms having lentical temperature dependence, and that the low-mperature behaviour is governed by mechanisms istinct from those effective in the audio-frequency nge at room temperature. A.

539.32

5041. The correction of elasticity measurements on slightly anistotropic materials. H. PURSEY AND H. L. COX. *Phil. Mag.*, **45**, 295–302 (*March*, 1954).

Expressions are derived for the average elastic constants of a polycrystalline bar, having circular symmetry about its principal axis and composed of material with cubic crystal symmetry. It is shown that the differences between these and the corresponding constants obtained for a material with completely random orientation depend in each case on the same function of the crystal orientation distribution, and therefore the complete elastic behaviour of the material may be determined from measurements of three independent quantities. In particular, it is shown how the true elastic constants of an isotropic specimen may be determined from the results of a series of longitudinal and torsional resonance tests, or from three measurements of travel-time of high-frequency pulses of mechanical energy through the material. When the orientation distribution is expressed in terms of zonal harmonics it is found that elastic anisotropy is caused solely by the presence of the component $P_4(\cos\theta)$. Stereographic charts are included showing the texture corresponding to this and three higher harmonics, thereby establishing a relation between the elastic behaviour of cubic materials and the results of X-ray measurements. A.

539.32 : 548.0

5042. On the nonlinear elastic constants of crystals. M. MATSCHINSKI. *C.R. Acad. Sci.* [*Paris*] **238**, 365–7 (*Jan.* 18, 1954) *In French.*

To the classical linear tensor relation between stress and strain is added a quadratic strain term to allow for nonlinear but reversible deformations. The numbers of additional nonlinear elastic constants are computed for each of the crystal systems.

A. D. LE CLAIRE

539.373 : 537.311.33

5043. Dislocations in plastically-deformed germanium. G. L. PEARSON, W. T. READ, JR AND F. J. MORIN. *Phys. Rev.*, **93**, 666–7 (*Feb.* 15, 1954).

Both *n*- and *p*-type germanium rods were deformed plastically by bending. Etch pits were observed on the two active slip planes. Hall effect, conductivity and lifetime were measured on both control and deformed samples. The results are consistent with the idea that edge dislocations in germanium are associated with acceptor-type energy levels in the middle or upper half of the gap. A.

539.374

5044. Approximations in linear viscoelasticity theory: delta function approximations. H. LEADERMAN. *J. appl. Phys.*, **25**, 294–6 (*March*, 1954).

The relationships between certain approximations that have been proposed recently in connection with the linear viscoelastic behaviour of noncrosslinked amorphous polymers are discussed. The approximations reviewed here are applicable with slight modifications to other types of linear response, for example, dielectric behaviour. A.

539.374

5045. The plastic deformation of ammonium dihydrogen phosphate. P. L. SMITH AND E. I. SALKOVITZ. *J. appl. Phys.*, **25**, 237–9 (*Feb.*, 1954).

Plastic deformation was produced at about 100°C in a single crystal of ADP which is normally considered to be brittle. The following four specimen orientations were studied by loading as a simple beam at temperatures from 90° to 115°C: (*a*) loaded along [110] axis normal to the (001) face (this orientation being the one of practical importance for all piezoelectric applications); (*b*) loaded along [100] axis normal to (001) face; (*c*) loaded along [010] axis normal to (100) face; (*d*) loaded along [001] axis normal to (100) face. Specimen (*a*) deformed more readily than the others. X-ray studies were made before and after deformation. Back-reflection Laue patterns revealed no difference before and after deformation (i.e. no asterism was detected). A modification of the Berg–Barrett grazing angle technique proved very satisfactory and revealed that structural fragmentation had occurred in these crystals. A.

539.389.4

5046. Effect of previous stress-strain history on the dynamic hysteresis loop for rubber in compression. D. M. DAVIES AND H. MCCALLION. Letter in *Nature* [*London*] **173**, 262–3 (*Feb.* 6, 1954).

Small hysteresis loops about different mean deformations in the stress-strain diagram are recorded at a constant frequency (100 c/s). The centres of the loops lie on a larger hysteresis loop obtained in very slow deformation (1 c/15 min). The mean slope of a small loop is a function of the mean deformation, and is different from the slope of the larger loop at that deformation. J. G. OLDROYD

539.4.011.2

5047. The yield strength of partly ordered Cu_3Au wires. W. D. BIGGS AND T. BROOM. *Phil. Mag.*, **45**, 246–8 (*March*, 1954).

The dependence of yield stress on the size of ordered domains was investigated by tensile deformation of polycrystalline wires of Cu_3Au. In agreement with a prediction by Cottrell it was found that the yield stress was greatest when the estimated domain size was about 50 Å. A.

539.4.016.2

5048. 16 percent aluminium-iron alloy cold rolled in the order-disorder temperature range. J. F. NACHMAN AND W. J. BUEHLER. *J. appl. Phys.*, **25**, 306–13 (*March*, 1954).

The methods of fabricating 16% Al-Fe from cast slab to thin-gauge sheet are described in some detail. The melting, casting, homogenizing, hot rolling and cold rolling at 575°c and room temperature are described. Particular attention is focused upon the 575°c cold rolling from the standpoint of the possible beneficial effects derived from an ordering reaction which occurs in this alloy. The technique of cold reduction from 0·007 in. to 0·0005 in. at room temperature is discussed. Magnetic data on a limited number of heat-treated laminated cores are given. Useful physical properties, other than magnetic, of previous limited interest because of the inability to fabricate the alloy into ductile strong thin sheets, are discussed. These properties include excellent oxidation resistance at high temperatures, good wet-corrosion resistance to certain chemical solutions and high electrical resistivity. A.

539.4.019 : 541.183

5049. Effect of gas adsorption on the mechanical strength of a metal wire. H. FORESTIER AND A. CLAUSS. *C.R. Acad. Sci.* [*Paris*] **238**, 207–9 (*Jan.* 11, 1954) *In French.*

It has been found that the tensile strength of Cu, Au and Pt wires depends on the nature of the ambient gas and has a maximum value in a vacuum, while values for different gases present a regular curve falling as the temperature of liquefaction of the gas increases. F. LACHMAN

539.431

5050. Damage as an initial stage of fatigue fracture. T. YOKOBORI. Note in *J. Phys. Soc. Japan*, **8**, 806 (*Nov.–Dec.*, 1953).

A certain degree of weakening is observed after a number of cycles in a fatigue test which is much less variable than the number of cycles to fatigue fracture. [See also Abstr. 5836 (1951), 4428 (1953).] J. G. OLDROYD

539.431

5051. Observations on the fatigue fracture of copper. N. J. WADSWORTH AND N. THOMPSON. Letter in *Phil., Mag.* **45**, 223–4 (*Feb.*, 1954).

Pure Cu specimens were tested in push-pull at 1 kc/s. Fatigue cracks originate in intense slip bands and spread through regions of high slip band density, leading to ultimate fracture. Removal of the slip bands by electropolishing reveals markings which are believed to be the incipient cracks. Annealing at 600°c for 1 hr did not remove the markings. Single crystals behave similarly, with the crack starting in a slip band and eventually deviating on a course approximately normal to the tensile axis. A. J. KENNEDY

539.434

5052. Relation between creep and relaxation of stresses. I. A. ODING, O. V. SOROKIN AND N. D. SAZONOVA. *Dokl. Akad. Nauk SSSR*, **92**, *No.* 3, 565–8 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*–152.

Creep under constant stress, and stress relaxation at constant strain are considered to be two speci cases of creep under arbitrary stress variations a attempts to relate curves for the two are made. It shown that the variations with heat treatment f each is consistent, in certain steels, with this vie and it is concluded that a steel cannot be resista to creep and not to stress relaxation. W. M. LOMB

539.5

5053. Mohs's hardness scale—a physical interpreta tion. D. TABOR. *Proc. Phys. Soc.* [*London*] *B*, 6 249–57 (*March*, 1954).

The Mohs hardness scale consists of ten mineral arranged in increasing order of hardness such tha each mineral will scratch the one on the scale belo it, but will not scratch the one above it. Althoug these minerals are generally considered to be brittle experiments show that under local indentation an during sliding their behaviour is primarily determine by the plastic properties of the minerals. Th suggests that there should be some relation betwee the Mohs hardness and the indentation hardness o the minerals. Experiments with metals show that i general a metal surface of indentation hardness H will be scratched by a point of hardness H_p if $H_p \geq 1{\cdot}2H_s$. Thus a scratch hardness scale can be con structed in which each standard has an indentation hardness at least 1·2 times greater than the preceding standard. The scratch hardness number is the proportional to the logarithm of the indentation hardness. Excluding diamond, which is anomalous this type of relation is found to apply to the Mohs standards, and it is found that each standard is approximately 60% harder than the preceding one. A

539.62

5054. Viscous properties of plastic lubricants and rotational resistance of anti-friction bearings. G. V. VINOGRADOV AND M. D. BEZBOROD'KO. *Dokl. Akad. Nauk SSSR*, **90**, *No.* 6, 1019–22 (1953) *In Russian.* English translation, *U.S. National Sci. Found. NSF-tr*-165.

Shows, experimentally, that with viscous (grease) lubricants, the part of a bearing resistance which depends upon the lubricant and also varies with temperature and speed may be determined uniquely in terms of the viscosity-temperature and viscosity-speed characteristics of the lubricant. J. W. MENTER

539.621 : 536.521

5055. The surface temperature of sliding solids. F. P. BOWDEN AND P. H. THOMAS. *Proc. Roy. Soc. A*, **223**, 29–40 (*April* 7, 1954).

The surface temperature developed at the points of rubbing contact between a metal and a transparent solid were determined by measuring the infrared radiation transmitted through the solid. It is shown that high, fluctuating temperatures occur, and the results are in general agreement with those obtained by other physical methods. Some measurements were made of the time required for the formation and decay of the "hot spots." In general, the maximum temperature rise is limited by the melting-point of the solid, but with readily oxidizable metals very high temperatures are occasionally observed because of the "burning" of the metal. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123

56. Carbon-14 isotope effect in the exchange action between carbon monoxide and phosgene. R. STRANKS. Letter in *J. chem. Phys.*, **21**, 2232 *ec.*, 1953).

Experimental values are larger than theoretical for e effects of the C^{14} isotope in unidirectional reac- ns. Accordingly the above exchange reaction was vestigated experimentally. For this the theoretical terminations are more reliable. Good agreement th the theoretical value of the equilibrium constant as found, both ion-chamber and Geiger-counter ethods being used. A. J. TAYLOR

541.123

057. The kinetics of phase transitions involving mer reactions. H. L. FRISCH AND C. WILLIS. *chem. Phys.*, **22**, 243–4 (*Feb.*, 1954).

Kinetic theory of phase transitions in which embryos f the new phase may grow or diminish by the cquisition or loss of monomer and dimer is presented. he error committed in neglecting the latter is shown o be negligible except in systems in which a large raction of the old phase is present in the form of imer. A.

541.123.5 : 531.752

Adsorption studies on clay minerals. *See Abstr.* 216

541.123.5 : 537.525.8

5058. The homomolecular exchange of nitrogen in a glow discharge. W. H. JOHNSTON AND R. M. ANSTETT. Letter in *J. chem. Phys.*, **22**, 146 (*Jan.*, 1954).

An homomolecular exchange reaction [Abstr. 2802 1954)] has been discovered in N under the influence of an electric glow discharge. The "effective electron yield" is ~1 within experimental error over the pressure range covered (2–6 mm Hg). This result seems to favour the atom-recombination, rather than the atomic-chain-reaction, mechanism of exchange.

F. LACHMAN

541.124

5059. The decomposition of ozone on the surface of glass wool. P. HARTECK AND S. DONDES. Letter in *J. chem. Phys.*, **21**, 2240–1 (*Dec.*, 1953).

The rate of decomposition was measured at 100°c on pure Pyrex glass wool over a wide range of concentration. It was found, contrary to previous work, that this heterogeneous reaction is of the first order. This may be explained by the combination of oxygen atoms, which are in thermal equilibrium with ozone and diffuse to the glass surface. The equilibrium constant was calculated ($5{\cdot}6\times10^{-9}$ for 100°c). It was found that one of each fourteen collisions of O atoms on the glass lead to recombination.

A. J. TAYLOR

541.124

5060. Comments on the thermal decomposition of ozone. P. HARTECK AND S. DONDES. Letter in *J. chem. Phys.*, **21**, 2241 (*Dec.*, 1953).

Accurate measurements of the thermal decomposition of O_3 show that this reaction is heterogeneous of the first order, and not homogeneous of the second order. It is pointed out at which stages of former experiments errors might have slipped in. [See also preceding abstract.] A. J. TAYLOR

541.124 : 530.145 : 530.162

5061. Equilibrium theory of unimolecular reactions. J. C. GIDDINGS AND H. EYRING. *J. chem. Phys.*, **22**, 538–42 (*March*, 1954).

Develops an equilibrium theory of unimolecular reactions, and shows how this theory is related to other theories, such as the Rice–Ramsperger–Kassel treatment. Unimolecular decomposition reactions and isomerization reactions are described in terms of statistical mechanics and quantum mechanics (potential energy surfaces). The nature of the transmission coefficient is discussed in detail. A.

541.126

5062. Suppression of bubble initiation of liquid explosives. E. JONES. Letter in *Nature* [*London*] **173**, 77–8 (*Jan.* 9, 1954).

The phenomena of vapour ignition inside the bubbles and of the initiation of the explosive are discussed in detail in relation to temperature and pressure. It is concluded that complex organic vapours which dissociate endothermally below the ignition point of the explosive form excellent explosion inhibitors. F. LACHMAN

541.126

5063. Theory of ignition considered as a thermal reaction. B. L. HICKS. *J. chem. Phys.*, **22**, 414–29 (*March*, 1954).

The history of a family of exothermally reactive solids is studied theoretically with the help of analytical and numerical calculations. The different members of this family of nonisothermal solids are obtained, by changing scales and values of parameters, from the basic model which describes a zero-order reaction of a semi-infinite slab of material subjected at its surface to heat transfer from a gas. For low initial temperatures of the solid, the heat transfer rate determines the ignition time while for high initial temperatures, this heating parameter is less important than the initial temperature, which controls the adiabatic ignition time. For the model used, the ignition time is generally quite sensitive to the duration of the external heating. Within the solid, it is found that the inner boundary of the region in which the chemical heat production is negligible moves inward along a diffusional type of path $x \propto t^{\frac{1}{2}}$ but that the point of maximum temperature, which develops after interruption of the external heating, follows a very different path. An analytical, approximate method of estimating minimum ignition time was tested by making comparison with numerical integrations and is probably accurate to 25% in the ignition time. The computational side of the theory presented here may be regarded as essentially complete for practical purposes until greater accuracy and detail are required by more critical applications than are now in prospect. Meaningful utilization of the computations in practical applications will not however be possible

until reliable measurements have been made of certain of the parameters for the solid—namely, activation energy, frequency factor and thermal conductivity—and the external heating—namely, gas temperature and heat transfer coefficient. A.

541.126 : 538.56

5064. Electromagnetic waves emitted on detonation of explosives. H. KOLSKY. Letter in *Nature* [*London*] **173,** 77 (*Jan.* 9, 1954).

Oscillograph traces showed that detonation of PbN_6, Ag_2C_2, NI_3 and P.E.T.N. caused small electric disturbances, the probe separated by a Perspex sheet from the explosive charge reaching a maximum potential after ~ 50 μsec and losing it over a few hundred μsec. The potential was negative for P.E.T.N., and positive for the remaining three explosives. F. LACHMAN

541.127

5065. On the theory of reaction rates. P. T. LANDSBERG. Letter in *J. chem. Phys.*, **21,** 2228–9 (*Dec.*, 1953).

It is pointed out that results obtained by Eyring and Wallenstein [Abstr. 5306 (1953)] can be manipulated into a form which is similar to a theory developed by Brillouin [*C.R. Acad. Sci.* [*Paris*] **184,** 589–91 (*March* 7, 1927)]. The necessary development is described. A. J. TAYLOR

541.127

5066. Rates of chemical reactions near equilibrium. B. J. ZWOLINSKI AND R. J. MARCUS. Letter in *J. chem. Phys.*, **21,** 2235 (*Dec.*, 1953).

A relation between reaction velocity and free energy, valid near equilibrium, which has previously been derived by arguments from the theory of absolute reaction rates, is here derived on the assumptions that the activated states of both forward and reverse reactions in a non-ideal bimolecular system are in equilibria, and that all chemical species participate in the reaction to the first order. Appeal is then made to the principle of detailed balancing. A. J. TAYLOR

541.127

5067. The rate of combination of methyl radicals. K. U. INGOLD, I. H. S. HENDERSON AND F. P. LOSSING. Letter in *J. chem. Phys.*, **21,** 2239 (*Dec.*, 1953).

An improved method of measuring the contact time of the reaction showed that results and conclusions described previously [Abstr. 4442 (1953)] must be altered. It was found that the pressure had indeed an influence on the reaction rate. This brings the results into agreement with work by other authors. A slightly lower value (1·5 kcal) was found for the activation energy. A. J. TAYLOR

541.127

5068. Modified transition state theory of reaction rates. F. A. MATSEN. *J. chem. Phys.*, **22,** 165–8 (*Feb.*, 1954).

The specific reaction rate for chemical reactions is formulated in terms of the total transmission coefficient in the reaction co-ordinate and a modified transition state, which differs from the original transition state only in the treatment of the reaction co-ordinate. If the total transmission coefficient is factored into two partial transmission coefficients, [illegible] modified theory gives the transition state theory [illegible] both the classical and the quantum-mechanic[al] particle-in-a-box treatments. It is then shown th[at] the momentum density in the virtual state over [a] symmetrical square barrier is that of a quantu[m] mechanical-particle-in-a-box at low momentum a[nd] that of a classical system at high momentum. Final[ly] the reaction-rate transmission coefficient is calculat[ed] from the modified theory for an unsymmetric squa[re] barrier and shown to depend on the temperature, t[he] activation energy and the thermicity of the reactio[n].

541.128 : 537.311.

Electrical conductivity of chromia-alumina dehydrogenation catalysts. *See Abstr.* 4536

541.128 : 537.311.

Electrical conductivity of hydrocarbon cracking catalyst. *See Abstr.* 4537

ELECTROCHEMISTRY 541.13

541.1

5069. Correction for spherical diffusion to the Il'kovič equation. J. KOUTECKÝ. *Czech. J. Phys.*, [illegible] 50–5 (1953).

By making this correction and simplifying the boundary conditions equations for the instantaneous current, the limiting diffusion current, and the half-wave potential are derived. [Cf. Abstr. 9111 (1951)] W. GOO[D]

541.132.3 : 621.389 : 621.317.7

5070. Electronic instrumentation applied to the chemical industry with special reference to pH measurement. G. HITCHCOX. *J. Brit. Instn Radio Engrs*, **13** 401–13 (*Aug.*, 1953).

This paper is principally concerned with the direct reading, continuous service pH-meter. Essentially a stable d.c. amplifier, its design is largely governed by the complex and inconvenient character of the electrode signal, and by the need for absolute rather than proportional accuracy; these factors are discussed in detail. A quantitative analysis of the major causes of electrical error is followed by sections on automatic temperature compensation, direct-coupled amplifiers and frequency conversion amplifiers, together with a note on the application of solid-state devices. Two typical though widely different commercial instruments are described. A[.]

541.13[3]

5071. The electrical conductivity of supercritical solutions of sodium chloride and water. J. K. FOGO, S. W. BENSON AND C. S. COPELAND. *J. chem. Phys.*, **22,** 212–16 (*Feb.*, 1954).

A description is given of the method used to measure the electrical conductivity of NaCl in steam at steam densities between 0·2 and 0·4 g/cm³. Values of the specific and equivalent conductances are tabulated at 378, 383, 388 and 393°c for various NaCl concentrations at different steam densities. Sodium chloride behaves as a weak electrolyte at all steam densities

. Estimates of the ion-pair dissociation constant based on Shedlovsky's method, indicate that K reases from about 9×10^{-3} to 6×10^{-7} as the steam sity decreases from 0·4 to 0·2 g/cm³. Preliminary lts for caesium chloride and hydrogen chloride in m indicate that caesium chloride is comparable trength with sodium chloride, but that hydrogen oride is a much weaker electrolyte. A.

541.133.1

2. Diffusion of K^{42+}, Rb^{86+}, and Ag^{110+} in NaCl stals. M. CHEMLA. *C.R. Acad. Sci.* [*Paris*] **238,** 4 (*Jan.* 4, 1954) *In French.*

The same method used previously [Abstr. 5160 53)] was applied to measure the diffusion constants these ions in NaCl. The graphs obtained of log D ainst $1/T$ for each ion were straight lines which were ictically parallel. The activation energies found re very similar to each other and to those of Na and investigated previously: 1·80 (Na^+), 1·92 (K^+), 98 (Rb^+), 1·85 (Cs^+) and 2·0 eV (Ag^+). The fusion coefficient of the alkali ions increases with e ionic mass. A. J. TAYLOR

541.135.5

073. Properties of the antimony microelectrode in queous alcoholic solutions. B. KAMIEŃSKI, Z. BYŁO ND B. WALIGÓRA. *Bull. Acad. Polon. Sci. Cl.* 3, **1,** o. 3–4, 137–141 (1953).

Curves are shown giving the variation of the otential of a Sb microelectrode in solutions of weak cids and bases in binary mixtures of methanol, thanol and propanol with water. It is claimed that ne electrode is very sensitive to small quantites of ne acids and bases (propionic, butyric, *n*-valerianic, -capronic, *n*-oenauthic, *n*-caprylic and *n*-myristic cids, cinchonine and brucine). W. GOOD

541.135.5

074. Transfer overvoltage at redox electrodes for everal consecutive transfer reactions. K. J. VETTER. Note in *Z. Naturforsch.*, **8a,** 823–4 (*Dec.*, 1953) *In German.*

Equations given previously [see Abstr. 8527 (1952)] are corrected, after consideration of the dependence of transfer overvoltage on current density for a redox system in which several electrons have been exchanged in the total electrode reaction by different transfer reactions. Examples are given for the Mn^{4+}/Mn^{2+} redox system and for the quinhydrone electrode.

H. H. HODGSON

541.135.5

5075. Analysis of the formation current in electrolytic oxidation of zirconium. J. J. POLLING AND A. CHARLESBY. *Proc. Phys. Soc.* [*London*] *B,* **67,** 201–10 (*March*, 1954).

When zirconium is oxidized electrolytically only a portion of the charge passed contributes to the growth of the oxide film produced. It is therefore assumed that the formation current consists of both ionic and electronic components, the former producing film growth, and the latter liberating oxygen. In this paper these components are measured separately. The ionic current is deduced from the observed weight increase. After correction has been made for dissolution of zirconium and for the trapping of volatile compounds within the film a figure of $0\cdot41\ \mu g\,cm^{-2}\,V^{-1}$ is obtained for the film growth. The electron current is determined from the rate of evolution of oxygen. If the remainder of the total current is ionic, there should result a weight increase of $0\cdot46\ \mu g\,cm^{-2}\,V^{-1}$, due to oxidation. The agreement between these two values, which is within experimental error, shows that the basic assumption, namely that both electron and ion currents flow, is correct. From the results the current efficiency, rate of formation, dielectric constant and film thickness are obtained. Under the conditions of the experiment the rate of film growth amounts to 30 Å per volt. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

5076. Photobleaching and photorecovery of dyes. G. OSTER AND N. WOTHERSPOON. Letter in *J. chem. Phys.*, **22,** 157–8 (*Jan.*, 1954).

Rapid photobleaching in the light from a 100 W tungsten lamp (or from a msec photographic flash bulb of methylene blue and of thionine (at concentrations 10^{-5} M) takes place when 10^{-3} M ascorbic acid or phenylhydrazine in aq. solution, or $SnCl_2$ in a variety of solvents, are used as reducing agents. The colour is not restored when the solution is kept in the dark in the complete absence of O_2. Photobleached products even in the absence of O_2 are restored to the original dye by irradiation with near u.v. At −78·5°C photobleaching and photorecovery are slower than at room temp., an effect ascribed to the greater viscosity of the medium at the low temp. Quantum yields are given. W. GOOD

541.14

5077. Photolysis and sensitization. W. DEKEYSER AND W. VAN DER VORST. *C.R. Acad. Sci.* [*Paris*] **238,** 344–5 (*Jan.* 18, 1954) *In French.*

Loening has shown that a sol of AgBr with excess of Ag is only slightly light-sensitive, unless gelatine or other S compounds is present. Loening offers an explanation involving photosensitive complexes, but the authors claim that the observed facts can be equally well explained by postulating a barrier layer.

N. CORCORAN

541.14 : 539.23

5078. Diffusion effects in the photochemistry of solid films. J. E. WILSON. *J. chem. Phys.*, **22,** 334–43 (*Feb.*, 1954).

Little work has been done, either experimentally or theoretically, on the problem of photochemical reaction kinetics in the solid phase, although this field is of practical importance in connection with the weathering of polymeric films and sheets. Reaction kinetics in solid films are greatly influenced by diffusion phenomena. The Laplace transformation technique offers a convenient method of solving many problems concerning the interaction of diffusion behaviour with reaction kinetics. The method is illustrated for the diffusion of a gaseous product from

an irradiated film, with and without reaction rate dependence on product concentration; and for the diffusion of a gaseous reactant into an irradiated film, with and without reaction rate dependence on reactant concentration. In each case the expression for dissolved gas concentration across the thickness of the film is computed, and the quantum yield for the reaction involved is expressed as a function of film thickness, diffusion coefficient, rate of light absorption and initial conditions. Equations for the effect of temperature variation and of intermittent light are derived in a few instances. A.

541.14 : 542.944

5079. Bromination of hydrocarbons. VII. Bromination of isobutane. Bond dissociation energies from bromination kinetics. B. H. ECKSTEIN, H. A. SCHERAGA AND E. R. VAN ARTSDALEN. *J. chem. Phys.*, **22**, 28–35 (*Jan.*, 1954).

For Pt VI, see Abstr. 8024 (1953). The kinetics of the gas phase photochemical bromination of isobutane to yield 2-bromo 2-methylpropane was investigated in the temperature range 40–95°C and the reaction found to proceed through an atom and radical chain mechanism analogous to that observed with a number of other hydrocarbons. The thermal reaction was studied at 112 and 130°C and shown to have the same mechanism except for the mode of production of bromine atoms. Bromination was inhibited by hydrogen bromide, a product of the reaction, and also by oxygen. The dissociation energy of the tertiary C–H bond in isobutane was found to be 89·6 kcal/mole at 0°K, in agreement with the idea that tertiary bonds are considerably weaker than primary bonds. A general review of activation energies of bimolecular reactions involved in bromination is given as well as recapitulation of values of C–H and C–C bond dissociation energies derived from bromination studies. A.

541.15

5080. Betatron irradiation of aqueous ceric sulphate solution. R. W. HUMMEL, A. B. VAN CLEAVE AND J. W. T. SPINKS. *Canad. J. Chem.*, **31**, 1203–10 (*Dec.*, 1953).

Ceric ions, from ceric ammonium sulphate dissolved in aerated 0·8 N sulphuric acid solution, were reduced by Co^{60} γ-rays and betatron X-rays of 23 MeV peak energy. G values were calculated on the basis of calculated electron distributions. A.

541.15

5081. Physicochemical effects of radio-frequency fields. H. H. YATES AND C. A. WINKLER. *Canad. J. Chem.*, **31**, 338–45 (*April*, 1953).

The outgassing of liquids has been studied under a variety of conditions including the application of a radio-frequency electric field. A large acceleration of the outgassing rate in the electric field was shown to result from convection currents established by the temperature gradient set up by the field. The significance of such a temperature gradient in a comparison of the chemical behaviour in such a field with that under normal thermal conditions has been considered. When account was taken of the thermal gradients induced by the field, a field of approximately 2000 V/cm and 1·5 Mc/s had no measurable effect on the rate of polymerization of styrene in bulk at 80°C.

541.

5082. Betatron irradiation of water saturated with benzene. G. R. FREEMAN, A. B. VAN CLEAVE AND J. W. T. SPINKS. *Canad. J. Phys.*, **31**, 448–56 (*April*, 1953).

The oxidation of benzene to phenol in dilute aqueous solution by Co^{60} γ-rays and betatron X-rays (23 MeV peak energy) is compared with the oxidation of Fe^{++} to Fe^{+++} under similar conditions. The ratio (yield of phenol)/(yield of Fe^{++} oxidized) was the same for Co^{60} and betatron radiations. The yield for the Co^{60} radiations was about 10% greater than the apparent yield for the betatron radiations, the difference probably being attributable to dosimetry determination at high energies (>1 MeV). It is concluded that both reactions are independent of energy and dose rate over the ranges investigated.

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.1

5083. Photoelectric investigations of electron interactions [Wechselwirkung] between a platinum surface and adsorbed hydrogen and oxygen atoms and molecules and N_2O molecules. R. SUHRMANN AND W. SACHTLER. *Z. Naturforsch.*, **9a**, 14–27 (*Jan.*, 1954). *In German.*

By bombardment of a Pt surface containing adsorbed hydrogen with low energy electrons (20–300 volt) and measuring the spectral photoelectric sensitivity with monochromatored radiation from a u.v. lamp it was found that the sensitivity at first increases and then decreases during the bombardment. It is suggested that at first the adsorbed hydrogen molecules are dissociated and that the resulting hydrogen atoms bring about a reduction in the value of the work function, ϕ, of the metal. Continued bombardment expels H atoms from the surface, ϕ thereby increasing and giving rise to a corresponding fall in the photo-sensitivity. Molecular O_2, like molecular H_2, produces little change in the magnitude of ϕ; O atoms produce an increase. The influence of adsorbed N_2O on ϕ at 83°K where thermal decomposition need not be considered provides proof of the suggestion that by adsorption the binding between nitrogen and oxygen is loosened and an explanation of the discovery by Hedvall *et al.* (1934) of the sudden increase in the activation energy of the Ni-catalysed decomposition of N_2O as the temp. rises through the Curie point. W. GOOD

541.18 : 541.135.5

5084. Ionic components of charge in the electrical double layer. D. C. GRAHAME AND B. A. SODERBERG. *J. chem. Phys.*, **22**, 449–60 (*March*, 1954).

The rate of change with concentration of the capacity of the electrical double layer on mercury has been measured. From this there have been calculated Γ_+, the excess of cations in the double layer, and Γ_-,

xcess of anions. The latter has been subdivided η_-^d, the excess of anions in the diffuse double and η_-^l, the excess of anions in the inner part e double layer. From these data it has also been ible to evaluate ψ^0, the potential of the outer nholtz plane. It is found that fluoride ion ains unadsorbed on mercury at all potentials stigated, including potentials anodic to the nax. Other anions are strongly adsorbed misorbed) when the mercury is positively charged, sometimes even when it is negatively charged. "hump" in the capacity curves of salts of such ns as chloride, bromide, acetate and nitrate, are d to be present in curves of C_-, the capacity ibutable to anions alone. No chemisorption of natomic cations could be detected. The kinetic ry of the diffuse double layer with constant ectric constant is found to fit the experimental lts within the expected accuracy. This fit extends electrolytes of the 1 : 2 and 2 : 1 types also. A method of evaluating salt adsorption at the ential of the electrocapillary maximum (e.c.max.) scribed and results are given. Likewise a new hod of determining C_+ at the e.c.max. is described l used. A.

541.18.043

5085. Generalization of the radial dilution square law ultracentrifugation. R. TRAUTMAN AND V. SCHUKER. *J. chem. Phys.*, **22**, 551–4 (*March*, 1954).

The classical square law of radial dilution, which ates the concentration of a single component to boundary position in the ultracentrifuge cell, has n examined and found to be valid for a single nponent as well as for a multicomponent system n though the sedimentation rates are dependent on ncentration. The square law has been generalized give corrected concentrations without the necessity determinating boundary positions explicitly. A tem of warped co-ordinates has been introduced simplify this application of the square law. A ecial template and its use is described which corporates both the warped co-ordinates and the seline and which enables very rapid reading of as from routine ultracentrifugal runs. A.

541.182.5

5086. The physical properties of gelatin solutions d gels. A. G. WARD. *Brit. J. appl. Phys.*, **5**, 85–90 *March*, 1954).

The composition and structure of gelatin are lated to the method of manufacture, and to the ysical properties of gelatin solutions and gels. The portance of the isoionic point, molecular weight stribution and a gel forming factor are discussed in nnection with the experimental results. A.

541.182.5

5087. Gel formation and molecular weight distribution in long-chain polymers. A. CHARLESBY. *Proc. oy. Soc. A*, **222**, 542–57 (*March* 23, 1954).

In long-chain polymers an insoluble network or el may be produced when a number of the separate olecules are linked together. A theoretical derivation is given of the relationship between the amount gel formed and the degree of cross-linking, in terms of the initial molecular weight distribution. It is shown that whatever the initial molecular weight distribution, incipient gelling occurs when there is on the average one cross-linked monomer per weight average molecule. The shape of the gel-crossing-linking curve depends on the ratio of z average, $z + 1$, . . . average molecular weight to the weight average. From experimental values of the curve it becomes possible to determine many of the constants of the molecular weight distribution in the original polymer. Expressions are derived for the number average, weight average and z average of the polymer as a function of cross-linking prior to gel formation, as well as the number and weight averages of the sol fraction after gelation. The average molecular weight between cross-links in the gel is calculated. A number of other functions of the sol and gel fractions are also given. A.

541.183 : 531.724

5088. Variation of the specific surface of coals during their carbonisation. A. BOYER AND G. FOUCAULT. *C.R. Acad. Sci.* [*Paris*] **237**, 893–5 (*Oct.* 19, 1953) *In French.*

Four different coals were heated at temperatures between 400° and 1000°C and the specific S of the cooled products determined by the sorption of nitrogen (B.E.T. method). For each coal S is ca. 1 $m^2 g^{-1}$ at 400° and 1000°C and rises to a maximum of ca. 8, 32, 32 and 70 $m^2 g^{-1}$ in the neighbourhood of 700°C. S. J. GREGG

541.183 : 537.311.33

5089. Kinetic model of activated adsorption on catalysts which are semi-conductors. J. E. GERMAIN. *C.R. Acad. Sci.* [*Paris*] **238**, 236–8 (*Jan.* 11, 1954) *In French.*

The activated adsorption of a molecule M on the surface of a semi-conductor (of electron affinity ε) is considered kinetically. The electrons liberated by partial ionization of the superficial layer D enter the conduction band and so encounter M, i.e. chemisorption may be represented $D + M \rightleftharpoons D\oplus + M\ominus$, (I) and the number of chemisorbed molecules N is regulated by the equation (I). The rate of adsorption (II) is equal to that of ionization of the centres D, and the rate of desorption (III) that of the process $M\ominus \rightarrow M + e$, (III). By equations (II) and (III) the equation to the isotherm is obtained as $(P/N) \exp -\{(\phi_e - \chi)/RT\} = f(T)$, ($\phi_e$ = work function at equilibrium, P = pressure, χ = depth of conduction bands, T = temperature). The analysis applies also to adsorption of donor molecules on p-type semiconductors. S. J. GREGG

541.183 : 537.311.33

5090. Relation between the form of the isotherm, the kinetics, and the variation of the heat of activated adsorption on semiconductor catalysts. J. E. GERMAIN. *C.R. Acad. Sci.* [*Paris*] **238**, 345–7 (*Jan.* 18, 1954) *In French.*

The relation $(P/N) \exp\{-(\phi - \chi)/RT\} = f(T)$ (see preceding abstract; P = pressure, N = number of molecules adsorbed per unit area, ϕ = work function, χ = depth of conduction band) can be combined with the experimental isotherm to give the heat of adsorption E and the energy of activation Q. Thus it

is possible to find the variation of E with N from the experimental isotherm, or to calculate the isotherm if the dependence of E on N is known. Two special cases are considered: (1) a linear variation of E with N leads to the isotherm $P = aN \exp(bN)$ (a and b are constants); (2) a Langmuir isotherm corresponds to $\partial E/\partial N = -RT(N_m - N)$. Expressions for the rate of adsorption can also be derived; from (1) $\partial N/\partial t = A \exp -(bN)$ and from (2) $\partial N/\partial t = A(N_m - N)$ (A = a constant). The variation of E with N corresponding to both (1) and (2) is in accord with the theory of semiconductors. S. J. GREGG

541.183.26 : 537.311.32

5091. The effect of physical adsorption on the electrical resistance of active carbon. W. W. SMELTZER AND R. MCINTOSH. *Canad. J. Chem.*, **31**, 1239–51 (*Dec.*, 1953).

The change of the electrical resistance of active carbon rods due to the reversible adsorption of vapours is described. The effects of six saturated hydrocarbons and ethyl chloride were studied. An interesting regularity in the results obtained with the hydrocarbons was found, namely that the extent of the resistance change at a given temperature and volume adsorbed is proportional to the number of carbon atoms in the adsorbate molecule. The alteration of the electrical conductivity of the active carbon by the physically adsorbed vapours and the adsorption isotherms are not modified by small quantities of chemisorbed oxygen. Ethyl chloride exhibits a more complex behaviour than the hydrocarbons. It is argued that the resistance measurements may be utilized to support the viewpoint that physically adsorbed saturated hydrocarbon molecules tend to lie flat on the adsorbent surface. Several possible explanations of the findings are examined and proved to be inadequate. A.

CHEMICAL STRUCTURE 541.2/.6

541.5

5092. Atomic valence states and chemical binding. W. MOFFITT. *Rep. Progr. Phys.*, **17**, 173–200 (1954).

A very general theory of the electronic structure of molecules is presented, and it is shown how particular instances of it represent the main sources of chemical binding. A method of describing the properties of an atom in a specific molecule is outlined. Particular attention is then paid to the electron-pairing theory of chemical binding, due to Slater and Pauling. It is demonstrated how an atom engaged in the formation of electron-pair bonds may be regarded as being in a non-stationary state. This is Van Vleck's valence state. The importance of the valence state concept is illustrated with reference to certain simple molecules. For example, the part played by the promotional energy of the oxygen atom's valence state in thermochemistry is outlined: whenever the bond additivity assumption is used, bond energies must be referred to atomic valence states rather than to their ground states. This is also important in assessing the excitation energies of certain molecular states, as is exemplified by the NH radical. Tables of valence states are drawn up which may be used in order to derive their promotional energies. The effect of orbital hybridization on the properties of atoms in molecules is illustrated. Finally, Mulliken's electronegativity scale is introduced and it is shown how this too depends on the energies of atomic valence states.

541.62 : 535.343.2

Structure of solid hydroxylamine and deuterohydroxylamine. *See Abstr.* 4363

541.62 : 539.

5093. Influence of solvent upon the energy difference between rotational isomers. A. WADA. *J. chem. Phys.*, **22**, 198–202 (*Feb.*, 1954).

The energy difference between the rotational isomers of the gauche- and trans-forms of 1,2-dichloroethane in various solutions have been calculated by use of a modified Onsager's reaction field. The following assumptions have been employed in the calculation: first, the cavity of the solute molecule is spheroidal; second, the dipole moment of the molecule is composed of two point dipoles which are placed at the foci of the spheroidal cavity, the focal distance being taken as equal to the distance between the contact points of the carbon and chlorine atoms in the dichloroethane molecule. The change of energy difference between rotational isomers in solvents thus computed has been found to be in close agreement with the experimental observations, that is those obtained by infrared absorption measurements as well as dipole moment.

541.67 : 538.

General principles of magnetochemistry; their application to the study of structures. *See Abstr.* 46

541.68 : 539.

5094. The volume effect in binary mixtures of some organic liquids. H.-G. MARKGRAF AND A. NIKURADSE. *Z. Naturforsch.*, **9a**, 27–34 (*Jan.*, 1954) *In German.*

The max. changes in volume, ΔV, on mixing hexane, carbon disulphide, methyl acetate, propionic acid, methylene chloride, dimethyl ether, cyclohexane, chloroform, benzene, butyl and ethyl ethers with each other and some other organic liquids, in binary mixtures, are recorded. A priori expectations about the nature of these changes are confirmed, in particular, large negative values are found with compounds containing hydrogen bridges. The order CH_2Cl_2, CCl_4, $CHCl_3$, CCl_2 : $CHCl$ is that of decreasing positive max. ΔV with other non-halogenated compounds. The connection between ΔV and the magnitude of intermolecular exchange forces between the components of mixtures, as deduced from other physical properties, is discussed. R. C. MURRAY

LABORATORY APPARATUS 542.1/.7

542.

5095. A small masticator for rubber plasticization. W. F. WATSON AND D. WILSON. *J. sci. Instrum.*, 3 98–9 (*March*, 1954).

The need for laboratory machines for plasticizing

ll amounts of elastomers is briefly discussed. The ciples and design are given of a totally enclosed ticator of 2–15 cm^3 capacity which has been quately tested in use. A.

542.2 : 66/67

5096. Glassblowing with dry air or an inert gas. Dousson. Letter in *J. Phys. Radium*, **14**, 734 (*Dec.*, 1953) *In French.*

he device described and shown diagrammatically or use by the glassblower when working apparatus n which moisture is to be excluded or which tains radioactive or other toxic substances. The ry and pressure of the dry air or inert gas into the paratus is controlled by the glassblower by inflating ubber washer against an orifice. S. WEINTROUB

542.7

5097. An apparatus for producing a number of erent gas mixtures for a long period of time. S. W. ILEY. *J. sci. Instrum.*, **31**, 93–5 (*March*, 1954).

The apparatus described can be modified to roduce any desired number of components to the mixture. Details are given of a micro-regulator ding the flowmeters and of a very simple choke t eliminates surges from the supply cylinders. A thod of overcoming changes in the flow rate due fluctuations in the atmospheric pressure is described. table of results showing the performance that can expected is included. A.

CHEMICAL ANALYSIS 543/545

545.82

5098. Examination of methods for detecting OH. M. Sanders, Jr, A. L. Schawlow, G. C. Dousmanis and C. H. Townes. *J. chem. Phys.*, **22**, 245–6 (*Feb.*, 1954).

The microwave spectrum of OH affords a new ethod of determining the abundance of OH in a low-essure gas mixture. This method applied to the oducts of a discharge in H_2O shows that certain evious methods for detecting the presence of OH dicals in fact are not sensitive to OH, but to some her reactive components of a discharge in H_2O. H radicals are obtained from a discharge in con-ntrations near 10% and with a lifetime of proximately $\frac{1}{3}$ sec. A.

545.822

5099. Selection of line pairs for the spectrographic nalysis of low alloy steel. D. L. Fry and T. P. Schreiber. *J. Opt. Soc. Amer.*, **44**, 159–62 (*Feb.*, 954).

A selection of analytical line pairs has been made or use in the spectrographic analysis of low-alloy teel. Lines were paired on the basis of similar xcitation potentials and wavelength separation. It as found that when excitation potentials of the ndividual members of a pair were within $\frac{2}{3}$ or $\frac{3}{2}$ of ach other, high accuracy and reproducibility were btained even under conditions of considerable natrix variation, and that within these limits mini-num wavelength separation between the lines becomes nore important than a closer match in excitation energies for improved reproducibility of line pairs. The lines selected and deviations obtained using these lines under considerable matrix variations are given in tabular form. A.

545.822

5100. Air-cooled electrodes for the spectrochemical analysis of powders. B. J. Stallwood. *J. Opt. Soc. Amer.*, **44**, 171–6 (*Feb.*, 1954).

A controlled source of excitation has been developed to eliminate selective volatilization and element interference effects encountered in the spectrochemical analysis of powders with the d.c. arc. A circular air jet, concentric with the sample electrode, was used to cool the unburned portion of the sample throughout the exposure and to stabilize the arc by surrounding it with a directed current of air. The effectiveness of the air jet was increased by placing the samples in deep narrow craters drilled in high-purity graphite electrodes. Uniform volatilization of even the volatile constituents was achieved and the spectral sensitivity of the elements was made relatively independent of the sample matrix. A maximum deviation from the mean of less than a factor of two was obtained for the sensitivity of any element when determined in a number of matrix materials including graphite, SiO_2, NaCl, Al and Zn. A significant improvement was made in the linearity of the intensity-concentration curves. A.

545.824 : 537.531

5101. New experimental arrangement for X-ray absorption analysis. J. Drahokoupil. *Czech. J. Phys.*, **1**, *No.* 3–4, 147–54 (1952).

Describes a new arrangement which can operate with a conventional type of sealed-off X-ray tube. It is designed to use two cylindrically bent crystals (NaCl) in a Johann focuser and perpendicular incidence of the radiation on the film, by which a large aperture, improved focusing and the possibility of a considerable separation of the lines having small Δx are obtained. This permits replacement of photographic recording by two Geiger–Müller counters placed next to each other thus fundamentally shortening the time needed for analysis. An arrangement is described permitting analysis on an area smaller than 0·1 mm^2; monochromatization of X-ray radiation is achieved by filtering, registration by a G.M. counter. A.

545.827 : 548.5

Radiochemical estimation of Na impurities in K salts. *See Abstr.* 5115

545.844

5102. Electrometric adsorption analysis of strychnine and brucine potentiometric chromatography. B. Waligóra and Z. Było. *Bull. Acad. Polon. Sci. Cl.* 3, **1**, *No.* 3–4, 143–7 (1953).

An Sb microelectrode placed in the effluent from an Al_2O_3 chromatographic column is used to detect the emergence of brucine and strychnine when an aqueous alcoholic solution of a mixture of these substances is passed down the column. Curves showing the potential of the electrode as a function of the volume of the effluent are given for both frontal and elution analysis. W. GOOD

CRYSTALLOGRAPHY 548

548.0 : 536.41

5103. Integral thermal expansion coefficient for the ionic and metallic crystals of the *B*-1 and *B*-2 types. J. CHOJNACKI. *Bull. internat. Acad. Polon. Sci. A*, *No.* 7–10, 321–8 (*July–Dec.*, 1951).

It is proposed that a rise in temperature produces a decrease in the ionic radii r as well as an increase in the lattice spacing a, and that the lattice becomes unstable and melts as soon as one plane of atoms can move without hindrance over another. The extent B of the changes in r and a, necessary to produce melting, is shown (1) to be a measure of the geometrical stability of the lattice, and (2) to be simply related to the integral thermal expansion. The stability of the *B*1(NaCl) and *B*2(CsCl) structure types is discussed in terms of the values of B calculated for various of their planes: an explanation appears of the comparative rarity of metallic compounds with *B*1 structures. Experimental values of the integral thermal expansion agree satisfactorily with the values derived from B. A. D. LE CLAIRE

548.0 : 536.41

5104. The melting point and thermal expansion of crystals of the *A*-1 and *A*-2 types. J. CHOJNACKI. *Bull. internat. Acad. Polon. Sci. A*, *No.* 3–6, 123–30 (*March–June*, 1951).

An application of the author's theory of melting (preceding abstract). If a_0, a_T and r_0, r_T are the interatomic spacings and ionic radii at 0° and T°K then melting of both *A*-1 (f.c.c.) and *A*-2 (b.c.c.) structures will occur when $r_0/r_T = a_T/a_0 = B = 1{\cdot}022$. B, calculated from measured thermal expansion coefficients $\left(B = 1 + \int_0^{\text{m.pt.}} \beta dT\right)$ is found for the majority of metals of these structures to be very close to the theoretical value. A. D. LE CLAIRE

548.24

5105. Mechanical twinning. R. W. CAHN. *Nuovo Cimento*, **10**, *Suppl. No.* 4, 351–87 (1953).

This review is notable in that it brings together in an accessible form much recent experimental work on twinning in calcite, nitre and quartz, as well as in metals, which has been carried out in Russia, where nearly all the recent work on the subject has been done. Twins produced in localized loading are classified into: elastic, which are lenticular and disappear on unloading; stopped elastic, which shrink but do not disappear; and residual, which are parallel-sided and do not shrink. The effects of various stresses and thermal treatments are discussed. The efficiency of twin boundaries as recrystallization centres has been studied. The confusion between kinking ("irrational twinning") and twinning proper is removed and there is a brief discussion of Martensitic transformations. The final section is a summary of two theories on the formation of twins under high local stress, and on their growth to a length limited by the applied load. The results appear to explain qualitatively the observations on elastic twins and their change over to residual lamellar twins, but are not at all detailed quantitatively. 78 refs. W. M. LOMER

54

5106. On some growth structures of metal cryst solidified from the melt. F. BLAHA. *Acta ph Austriaca*, **8**, *No.* 2, 141–66 (1953) *In German.*

Crystals of Zn, Cd and Sn were grown by Czochralski technique. Various types of grow structure occurred, depending on the growth co ditions, especially the temperature gradient. lineage structure, continuous throughout the cryst in the form of columns with a very regular hexagon cross-section, could be obtained; the surface ener conditions are discussed. Low index planes a vicinal planes at the phase boundary, of several squa mm extent, were obtained on crystals grown in hemispherical shape. J. FRAN

54

5107. Growth processes for crystals far from ph equilibrium. L. GRAF. *Z. Naturforsch.*, **8a**, 824 (*Dec.*, 1953) *In German.*

Growth processes are classified into "tangentia growth, a spreading of successive layers on low-ind crystal planes, or "normal" growth, when atoms ju the crystal at random positions and remain the irrespective of the behaviour of neighbours. The fi is dependent on the presence of nuclei (e.g. scre dislocations). The second may occur on high-ind planes and growth near equilibrium. The form the crystal in the second case is determined by surfa energy and rate of depletion of solute (or disposal latent heat). Dendritic forms are analysed, and it suggested that the diameter of the dendrites is dete mined by the shear strength and surface energy, a that these also control the thickness of some lamell growth layers. W. M. LOM

548

5108. Synthetic sodium chloride crystals; refracti index and lattice constant. G. ERICSSON. *Ark. Fy* **7**, *Paper* 34, 415–21 (1954).

The preparation, by the method of Kyropoulos, crystals, illustrated, of 10 cm diameter and 10 c length, of good optical quality, is described. Deta of the apparatus used are given together with diagra of the furnace, crystal holder and stabilizer circu From the crystals 60° prisms with faces 5×5 cm we cut and polished, and used to determine the refracti indices for the hydrogen C and F lines and t helium D line. The results were somewhat lower tha for natural NaCl. X-ray determinations on cryst plates 12×20×1 mm obtained by cleavage gave t value 5627·70 XU for the edge-length of the cell. S. WEINTROU

548

5109. An apparatus for preparing sodium chlori crystals having large specific surface. D. M. YOUN AND J. A. MORRISON. *J. sci. Instrum.*, **31**, 90- (*March*, 1954).

An apparatus is described for preparing crystals sodium chloride of mean particle size in the rang 0·01 μ to 1 μ at rates as large as 0·8 g/hr. Vapou is swept from the surface of molten sodium chlori in a turbulent stream of nitrogen and carried into a

:rostatic precipitator where the small particles collected. Although electron micrographs cate that the particle size distribution is broad, e average specific surfaces (up to 64 m^2/g) have n attained. A.

548.5

0. Crucible-free drawing of silicon single crystals. EMELS. Note in *Z. Naturforsch.*, **9a**, 67 (*Jan.*, 1954) *German.*

he method of Abstr. 5195 (1953) is used with h.f. ting of the molten zone. The crystals were grown m 99·8% pure sintered material. They were formly *p*-type and of hexagonal cross-section with [111] axis as the preferred growth direction.

S. WEINTROUB

548.5

11. Metal whiskers. S. E. KOONCE AND S. M. RNOLD. Letter in *J. appl. Phys.*, **25**, 134–5 (*Jan.*, 54).

Further electron microscope observations on tin iskers showed variation in dia. from 0·05 μ to μ, although 2μ was most frequent. Temporary fset in growth direction may be due to turning. piral growth forms were also observed.

J. W. MENTER

548.5

112. Interferometric studies of the slip phenomena the growth of palmitic acid crystals. A. R. VERMA. *cta cryst.*, **7**, 270–1 (*March*, 1954).

Palmitic acid crystals grown from solution have een studied by the application of multiple-beam terferometry and phase-contrast microscopy. Joining with one another of crystal monolayers and other rystal plates having a series of growth steps have een illustrated. Of special interest are the patterns hich show that the internal slip of molecular layers hich has been reported by Anderson and Dawson for nly monomolecular layers can take place over istances ~1000 Å. The dislocations taking part in his slip would be those with multiple Burgers vector nd thus these observations are evidence of the novement of large dislocation groups. A.

548.5

5113. Spiral growths on large crystal surfaces. H. RAE AND A. E. ROBINSON. *Proc. Roy. Soc. A*, **222**, 558–62 (*March* 23, 1954).

Means have been developed for maintaining observation of the individual faces of a large crystal while it is in process of growing or dissolving under controlled conditions. This has made possible an investigation into the cause of twinning occurring in lithium sulphate monohydrate crystals. Growth spirals have been detected on the two pairs of [110] wedge faces at opposite ends of the polar axis. The spirals have been shown to have characteristic shapes which are similar to the etch figures which distinguish the respective ends of the polar axis. The spirals and etch figures on the adjacent faces of a wedge pair are oppositely oriented and their approximate angular relations to the crystallographic axes have been ascertained. An estimate of the step height of the spirals indicates them to be about 3000 Å. The width of the twinned growth striae which are liable to occur during crystal growth is of almost the same magnitude. It has been established in this work that the incidence of twinning is associated with a condition of high supersaturation in the nutrient solution and is frequently accompanied by spontaneous microcrystallization. The present observations therefore are considered to provide evidence that the growth mechanism is by the addition to an active edge of large unit blocks which have been preformed in solution as ordered clusters. A.

548.5 : 539.374

5114. Crystal growth and plasticity. W. KOSSEL. *Z. Naturforsch.*, **8a**, 815–23 (*Dec.*, 1953) *In German.*

The introduction of dislocations to explain plastic flow has been extended to growth of crystals from the vapour. The author considers all kinds of growth from liquid and from solid by recrystallization, phase change, and mechanical twinning. Many details of the atomic motion in a bubble model under deformation are given, but it is concluded that the random heat motion still plays a major part in all but the primary crystallization from the gas. W. M. LOMER

548.5 : 545.827

5115. Enclosure of K by $NaNO_3$ crystallized in solution. Application to radiochemical estimation of Na in KNO_3. J. PAULY. *C.R. Acad. Sci.* [*Paris*] **238**, 80–2 (*Jan.* 4, 1954) *In French.*

See also Abstr. 2042 (1953). When $NaNO_3$ crystallizes out of a saturated solution in which KNO_3 is also present, some K is enclosed in the $NaNO_3$ crystals. The amount is proportional to the K-concentration, the proportionality constant being 0·019. This was found by the use of radioactive K^{42}, which was prepared by irradiation of ordinary K in the atomic pile. If KNO_3 was used which contained some Na impurity, the measured enclosure was much larger, owing to the fact that the Na impurity also became radioactive during the irradiation, Na^{24} being formed. This effect was investigated: certain known quantities of $NaNO_3$ were added to the KNO_3 samples which were irradiated by neutrons, and afterwards brought into a saturated solution of $NaNO_3$. Crystals formed on cooling, and a linear relation was found between the amounts of radioactive Na inserted and enclosed in the crystal. This test makes it possible to estimate Na impurities in K salts in concentrations of 10^{-4}. A. J. TAYLOR

548.5 : 551.583

5116. On the question of the passive orientating influence of a solid substratum on growing crystals. P. A. SHUMSKIĬ. *Dokl. Akad. Nauk SSSR*, **93**, *No.* 1, 51–4 (1953) *In Russian.*

A Fedorov universal stage was used to locate the optic axes of ice crystals growing on a non-isomorphous, plane substrate. Examining batches of about 100 crystals each time, stereograms showing the preferred orientations of the optic axes under various growing conditions were plotted. The favoured orientation with the base at −35° was perpendicular to the base; for slow cooling (base −6°) growth was chaotic; when the water was colder than the base the optic axes tended to be parallel to the base. For growth by sublimation a similar dependence on the water vapour pressure gradient was found. Applications to the investigation of climatological history are suggested. A. L. MACKAY

548.51

5117. On the question of the stability of crystal nuclei in overheated melts and undersaturated solutions. C. W. CORRENS. Note in *Naturwissenschaften*, **40**, *No.* 24, 620 (1953) *In German.*

It is pointed out that one way to test whether crystal nuclei can exist in melts above the melting point is to use an optically active crystal, e.g. $NaClO_3$ which is not active in the liquid state or in solutions. It is reported that heating $NaClO_3$ above the melting point 269 ± 1°C by 1 and 3°, or crystallization from solutions of 9·1% and 8·7–18·4% under and over saturation respectively showed no nuclei and that similarly for right- and left-handed quartz powder no seed crystals were found. S. WEINTROUB

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 534.131 : 535.375.5

5118. Theory of the normal modes of vibration in crystal. S. YANAGAWA. *Progr. theor. Phys.*, **10**, 83–94 (*July*, 1953).

The normal modes of vibration in crystal have been determined by the group-theoretical method, familiar in the theory of molecules. The secular equation for determining the frequencies of normal modes has been reduced to lower degrees by making use of the translational, crystal and *K*-groups. Frequency-distribution curves have been obtained for a few types of crystals, with a brief reference to 2nd-order Raman effect. A.

548.7 : 536.7 : 539.3 : 539.11

The ideal crystal at absolute zero. *See Abstr.* 4775

548.7 : 537.226.2

5119. Ferroelectricity and crystal structure. II. H. D. MEGAW. *Acta cryst.*, **7**, 187–94 (*Feb.*, 1954).

For Pt I, see Abstr. 6757 (1953). Ferroelectrics are crystals with pseudosymmetric structures of polar symmetry in which the direction of polarity can be reversed by an applied field. They are found when the directed bond system of certain atoms changes with temperature while the ionic character of the structure is still important. If only one kind of atom suffers such a change, the resulting displacements are likely to have non-polar symmetry; if two change together, there is a good chance that the displacements of each kind of atom will all be parallel, and the substance therefore ferroelectric. These ideas are applied to the perovskite family, where the importance of the homopolar character of the O atom is emphasized; to KH_2PO_4, where the significance of the K atom is deduced from the geometry of the structure, and the contrast with $ND_4D_2PO_4$ is discussed; to Rochelle salt, where attention is again directed to the K atom, and the chemical implications of theories of ordering in the hydrogen bond are noted; and to $LiNbO_3$, where the room-temperature structure found by Bailey is shown to be that of a "frozen ferroelectric" derived from the ideal perovskite structure. A.

548.7 : 536.

5120. Statistical theory of hindered rotation in mo cular crystals. II. Quantum effects. T. NAKAMU *Progr. theor. Phys.*, **10**, 95–107 (*July*, 1953).

For Pt I, see Abstr. 7455 (1952). Aims at explain the quantum effects on the phase transformations o to molecular hindrance in solid hydrogen halid Although the transition points of these substances situated at such high temperatures that the behavio of the system might be regarded as almost classic quantum correction effects exist, as can be seen in isotope effects. For the purpose of studying th effects the Hartree approximation method is us where the Hamiltonian contains kinetic operators addition to the intermolecular potential ones. T location of the transition point and the jump in specific heats are obtained, where the phase tra formation is of the second kind. In these expressio the moment of inertia of the molecule is contain Making use of the transition points of HBr and H the transition points of DBr and DI are obtained 91·8°K and 71·7°K respectively, in qualitative agre ment with the results observed by Clusius and Wi Further, the transformation heats prove to increa as the quantum effect decreases, which is in agreeme with the observations. The critical value of the ra of the hindering potential to the moment of inert beyond which any ordered state cannot be realized, also obtained.

548.7 : 539.1

5121. Radiation damage effects on order–disorder nickel–manganese alloys. L. R. ARONIN. *J. ap Phys.*, **25**, 344–9 (*March*, 1954).

Effects of fast neutron irradiation in a nucle reactor on order–disorder in a series of nickel–ma ganese alloys ranging from 16·5 to 31·9 atom per cent manganese have been studied by resistivi and magnetic induction measurements. Attainme of an "irradiated state" differing from either co work or thermal disordering is suggested by com parison of exposure results on initially cold-wo disordered and initially thermally disordered Ni_3M In a region from 16·5 to approximately 22% ma ganese, thermally disordered alloys are marked affected by irradiation. These effects also appe to be superposed on the disordering produced b irradiation of initially ordered alloys. From the retical exponential dependence on period of irradia tion, fast neutron disordering of Ni_3Mn is determine by relating the Bragg and Williams order parameter quadratically with resistivity and linearly with mag netic induction. This leads to an estimate of 500 for the ratio of the number of atomic replacement to primary collisions with neutrons of energy in exces of 0·5 MeV. A

548.

5122. A note on the group analysis of the wav functions of valency electrons in a crystal. E. AN TONČÍK AND M. TRLIFAJ. *Czech. J. Phys.*, **1**, *No.* 3–4 97–109 (1952).

Deals with the group analysis of the wave function of valency electrons in the first Brillouin zone o metallic aluminium and magnesium, and shows ho it is possible in general to construct an irreducibl

esentation of a space group for the case that this p contains screw axes and gliding planes. A.

548.7 : 537.311.1

5123. On the interaction of additive electrons with rization in ionic crystals. I–II. Y. TOYOZAWA, INUI AND Y. UEMURA. *Progr. theor. Phys.*, **9**, –77 (*June*); **10**, 57–71 (*July*, 1953).

he authors express the energy increase of an ionic tal due to arbitrary polarization in quadratic ns of two parts of polarization from the stand- at of the dielectric continuum. Using this formu- on they investigate the motion of an additive tron in an ionic crystal under interaction with the arization which the electron produces around lf, especially in the case when there is a trapping ential. They show that one is led to the usual thod of treating such problems suggested by Mott l Gurney, when one uses the adiabatic approxima- n (in the sense of Born and Oppenheimer) for the stem of an additive and the crystal electrons. On other hand, if Hartree's approximation for the stem is used, another method of treating these oblems is obtained. The latter method is applied the calculation of various thermal and optical ergies of the *F*- and *F'*-centres, conduction electrons d polarons, with a simplified model. The essential pects of this method are stressed in the last section. A.

548.7

124. Group theoretical investigation of the elec- onic bands in the diamond lattice. W. DÖRING AND . ZEHLER. *Ann. Phys.* [*Leipzig*] **13**, *No.* 1–5, 214–28 953) *In German.*

The irreducible representations of the space group f diamond are found. With their aid conclusions re drawn about the symmetry conditions for the lectronic wave-functions and the relation among the ands. F. ANSBACHER

548.7

5125. On the theory of the lattice structures of quatervalent elements. U. DEHLINGER AND H. SCHENK. *Z. Phys.*, **136**, *No.* 3, 344–51 (1953) *In German.*

The method used by Bloch, Hund and Ghanzhorn n the case of diamond is applied to the case of tetra- gonal white tin, and the integrals occurring in the perturbation calculation are discussed. As distinct from the case of grey tin, an additional splitting of the bands, and consequent overlapping of the partial bands, is found. The stabilities of the lattices are in qualitative agreement with experience. W. A. HEPNER

548.7

5126. Distortion of a crystal by point imperfections. J. D. ESHELBY. *J. appl. Phys.*, **25**, 255–61 (*Feb.*, 1954).

The expression $\mathbf{u} = c\mathbf{r}/r^3$ (where c is a constant) sometimes assumed for the displacement around a point imperfection (interstitial or substitutional impurity, lattice vacancy) gives a non-zero stress at the surface of the solid. The additional "image displacement" necessary to insure that this stress vanishes is usually neglected, but may be important. For example, it accounts for from 30 to 50% of the volume change produced by such defects. This and other effects of the image term are discussed. Miller and Russel have pointed out that for a point imperfection near the centre of a sphere the apparent volume change deduced from measurements of the X-ray lattice constant is greater than the geometrical volume change. It is shown that the reverse is true when the defect is near the surface, and that for a large number of defects scattered uniformly through the sphere the geometrical and X-ray expansions are equal. It can be shown quite generally that a body of arbitrary shape is expanded uniformly by a statistically uniform distribution of point imperfections, and that the X-ray diffraction pattern is altered in the way to be expected for such an expansion. To establish this, however, it is essential to take the image terms into account. A.

548.7

5127. The interaction between equilibrium defects in the alkali halides: the "ground state" binding energies between divalent impurities and vacancies. F. BASSANI AND F. G. FUMI. *Nuovo Cimento*, **11**, 274–84 (*March* 1954).

The binding energies of divalent impurity ions (Cd^{++}, Ca^{++} and Sr^{++}) and positive-ion vacancies at the distance of next-nearest neighbours have been computed in NaCl and KCl crystals using the Born–Mayer model of ionic solids. The results indicate that the binding energy increases with the ionic radius of the impurity and is somewhat smaller in KCl than in NaCl. They compare favourably with the available experimental estimates of the binding energies for Cd^{++} in NaCl and for Sr^{++} in KCl but do not confirm the considerable difference between the binding energies for Cd^{++} and Ca^{++} in NaCl that some experiments had indicated. A.

548.7 : 537.312.5

5128. Proof of traps in single crystals of CdS. W. MUSCHEID. *Ann. Phys.* [*Leipzig*] **13**, *No.* 6–8, 322-6 (1953) *In German.*

Maxima are observed in the dark current of CdS crystals when warmed which are analogous to glow curves for phosphors. The influence of oxygen on electron traps is studied. G. F. J. GARLICK

548.7

5129. Injection of positive holes in the alkali halide crystal. Y. UCHIDA AND Y. NAKAI. Note in *J. Phys. Soc. Japan*, **8**, 795–6 (*Nov.–Dec.*, 1953).

By heating a KI crystal at 500°C between a plane graphite electrode and a platinum point electrode, and with the latter 250 V positive, *V*-centres enter from the point and migrate to the graphite cathode. They are identified by comparing the absorption spectrum during this flow with that for *V*-centres produced by heating the crystal in iodine vapour.

G. F. J. GARLICK

548.7

5130. *F*-center wave functions in alkali halides. D. L. DEXTER. Letter in *Phys. Rev.*, **93**, 244–5 (*Jan.* 1, 1954).

It is claimed that the spin resonance line for the *F*-centre can be interpreted on the basis of a simple radial field at the negative ion vacancy as well as by the theory of Kahn and Kittel [Abstr. 2546 (1953)]

which assumes the *F*-centre wavefunction to result from a linear combination of orbitals centred on the 6 neighbouring positive ions. G. F. J. GARLICK

548.7

5131. Theoretical calculations of *F*-center energy levels. J. A. KRUMHANSL. Letter in *Phys. Rev.*, **93**, 246 (*Jan.* 1, 1954).

548.7

5132. The quantum yield of the $F \rightarrow Z_1$ conversion in KCl with Sr impurity. P. CAMAGNI, G. CHIAROTTI, F. G. FUMI AND L. GIULOTTO. Letter in *Phil. Mag.*, **45**, 225–8 (*Feb.*, 1954).

A study is made of the bleaching of the *F*-band in additively coloured crystals containing divalent strontium ions. The disappearance band of the *F*-band is accompanied by growth of the Z_1-band due to Sr^{++} centres. The minimum oscillator strength for the Z_1-band is deduced as 0·84 (see also abstract following). G. F. J. GARLICK

548.7

5133. The association energy between positive divalent impurities and positive ion vacancies in NaCl and KCl crystals. F. BASSANI AND F. G. FUMI. Letter in *Phil. Mag.*, **45**, 228–30 (*Feb.*, 1954).

The association energy is calculated using the method of Reitz and Gammel [Abstr. 7380 (1951)] for Cd^{++}, Ca^{++} and Sr^{++} ions in NaCl and KCl. The association energy is found to increase with ionic radius of impurity and values are a little smaller in KCl than in NaCl. This is due to larger inward distortion around the impurity caused by contact between positive and negative ions which does not occur in KCl and to the fact that the impurity ions are smaller than K^+ but larger than Na^+. G. F. J. GARLICK

548.7

5134. X-ray coloration of alkali halides. D. L. DEXTER. *Phys. Rev.*, **93**, 985–92 (*March* 1, 1954).

Processes of importance in the coloration of solids by X-radiation are discussed on the basis of Seitz's hypothesis that vacancies are created at jogs on dislocations or at other imperfections. The interaction between *F* centres and dislocations is calculated, and it is shown that *F* centres located within about 50 Å of edge-type dislocations would experience measurable broadening and perhaps shifting of their absorption peaks, in contradiction of experiment. From the available energy in the form of point thermal pulses, it is shown that most vacancies freed from jogs or other sources probably make less than a thousand atomic jumps during X-irradiation at He temperatures and hence are unable to diffuse more than about 100 Å from their sources. The tunnelling of *F*-centre electrons to positive-hole centres is calculated, and it is concluded that tunnelling can occur with high probability over a distance of ~ 30 Å by an electron in its ground state, ~ 40 Å in its first excited state. Such tunnelling is important in limiting local *F*- and *V*-centre concentrations even at He temperature in the dark. Crystals achieving macroscopic concentrations of the order 10^{18} cm^{-3}, it is concluded, must contain very high densities of vacancy sources to be consistent with the requirements of both the large tunnelling range and the small diffusion distance. A.

5

5135. Effect of pressure on *F*-center absorption alkali halides. I. S. JACOBS. *Phys. Rev.*, **93**, 993–1 (*March* 1, 1954).

Measurements are reported for the effect of hyd static pressure to 5000 atmospheres on the *F*-cen absorption of seven alkali halides. An interpreta is made of the shift of the absorption band maxim with pressure, and of the difference between the s with pressure and that with temperature. The s with pressure depends almost entirely on the lo interionic distance at the *F* centre. The shift w temperature is largely governed by this same fact but it must be supplemented by a contribution fr the interaction of the *F*-centre electron with optical vibrations of the lattice. Effects of pressure-induced structure transformation in Rb are described for both photochemically and additiv coloured crystals.

548.73/.74 : 539.26/

X-ray and electron investigation of materials. *Abstr.* 5027–35

548.7

5136. The reflexion and transmission of X-rays ne the Bragg angle in perfect absorbing crystals. BROGREN. Letter in *Acta cryst.*, **7**, 211–13 (*Fe* 1954).

Experiments have been performed with both t monochromator and the specimen crystal in eit the Bragg or the Laue position, and curves of i tensity of reflection and transmission against ang are given. The Laue–Laue arrangement is foun to give the narrowest peaks of intensity. A. R. STOK

548.7

5137. Description of a retigraph (apparatus allowi direct photography of the reciprocal lattice of a crysta R. GAY AND J. CLASTRE. *J. Phys. Radium*, **14**, 53 S 55 S (*Dec.*, 1953) *In French.*

The construction of a retigraph on the lines of th of de Jong and Bouman [*Zeitschrift für Kristall graphie*, **98 A**, 456 (1938)] is briefly described, an some applications to imperfect crystals are men tioned. A. R. STOK

548.73

5138. Absolute adjustment of a Geiger–Müller counter goniometer. M. TOURNARIE. *J. Phys Radium*, **15**, *Suppl. No.* 1, 11 A–15 A (*Jan.*, 1954) *I French.*

The adjustments described are for making the lin focus of the source, the axis of rotation of the speci men, and the counter window, all parallel; for adjust ing the zero mark of the scale; and for making the reflecting planes of the specimen parallel to the axis of rotation. The goniometer is a Norelco large angle instrument. A. R. STOKES

548.73

5139. Correction of the systematic error due to continuous recording with an X-ray spectrometer. M. TOURNARIE. *J. Phys. Radium*, **15**, *Suppl. No.* 1, 16 A–22 A (*Jan.*, 1954) *In French.*

Describes a mathematical line-profile correction for errors due to time-lag in a continuously recording Geiger-counter spectrometer. A. R. STOKES

548.733

0. A simple method for the precision measure-nt of lattice-constants. H. J. GOLDSCHMIDT. *ci. Instrum.*, **31**, 82–3 (*March*, 1954).

An instrument is described for the accurate measure-nt of lattice-spacings on X-ray powder photo-phs, which simulates the geometric conditions sting on the camera while the pattern was obtained. ises the circular goniometer principle for the direct ermination of diffraction angles, and could replace recision travelling microscope. A.

548.733 : 537.542

41. Use of a crystal counter in X-ray crystallo-aphy. Z. MIHAILOVIC. *C.R. Acad. Sci.* [*Paris*] **238**, 2–4 (*Jan.* 25, 1954) *In French.*

Counters were made of small crystals of CdS or gI with graphite coatings for electrodes. Currents 10^{-11} to 10^{-9} A were passed by the crystals. Some amples of their performance are given. A. R. STOKES

548.734.8 : 535.247

142. Photometry of single-crystal X-ray photo-raphs. S. C. WALLWORK AND K. J. STANDLEY. *cta cryst.*, **7**, 272–5 (*March*, 1954).

The derivation of intensities from single crystal -ray photographs is discussed, and a method of irect photometry of the negative is described in etail. The errors likely to occur are examined, nd it is shown that they do not usually exceed 10% n those cases where the variation in spot area is less han 2 : 1. An alternative photometric procedure is uggested which may prove advantageous when large ariations in spot area are found. A.

548.734.84

5143. X-ray scattering by aggregates of bonded toms. IV. Applications to the carbon atom. R. MCWEENY. *Acta cryst.*, **7**, 180–6 (*Feb.*, 1954).

For Pt III, see Abstr. 8087 (1953). The methods of previous parts are applied in the calculation of effective scattering factors for the carbon atom in diamond and in graphite, taking full account of the bonds. The factors are no longer isotropic, but the various extreme *f*-curves do not depart very greatly from that for the isolated atom; the differences may be significant for carbon, and for the other strongly bonded, light atoms common in organic molecules, but probably not elsewhere. Further progress, and the full utilization of bonded-atom factors, would seem to demand a thorough investigation of thermal vibration and of "temperature corrections." A.

548.735

5144. On homometric structures. R. HOSEMANN AND S. N. BAGCHI. *Acta cryst.*, **7**, 237–41 (*March*, 1954).

Structures which have the same squared transform but which are neither congruent nor enantiomorphic are defined as homometric structures. Homometric structures can be expressed systematically by means of the convolution operation; their analysis starts out from the so-called *Q*-function. They may be conveniently classified as follows: I. Pseudohomometric structures.—(*a*) Homometric structures which under suitable affine transformations degenerate to enantiomorphic or congruent structures. (*b*) Structures which are homometric only for infinitely large crystals. II. Homomorphs.—Homometric structures which remain homometric under any arbitrary affine transformation. A general expression of finite homometric structures which covers all the known examples is given by an integral equation of the folding type; its degenerate cases are discussed. A.

548.735

5145. A systematic method for calculating volumes of polyhedra corresponding to Brillouin zones. D. P. SHOEMAKER AND T. C. HUANG. *Acta cryst.*, **7**, 249–59 (*March*, 1954).

In problems involving the interpretation of crystal structures of metals and intermetallic compounds, the volumes of polyhedra (in wave-number space) corresponding to Brillouin zones, defined by crystallographic forms or groups of forms with large X-ray structure factors, are frequently calculated in order to ascertain how well the polyhedra accommodate the quantum states of assumed numbers of valence electrons per unit cell. This procedure depends upon a long-established apparent analogy between Brillouin zone stabilization and diffraction of the slow-moving valence electrons by the crystallographic planes corresponding to these forms, and upon the reasonable assumption that the structure factors for the diffraction of these slow electrons bear essentially the same qualitative relationships to one another as the structure factors for fast electrons or X-rays do. While the geometrical problems involved in calculating the volume of and number of quantum states contained in such a polyhedron are relatively simple when but one form is involved, the polyhedra corresponding to more than one form frequently truncate one another and the computation of the volume of the minimum truncated polyhedron for several forms is rather complicated. Methods for systematizing and simplifying these geometrical problems have been worked out, and are described here for the convenience of workers faced with the determination of the shapes and volumes of such polyhedra. A.

548.735.4

5146. Precise determination of lattice parameters of polycrystalline materials by means of X-rays. A. KOCHANOVSKÁ. *Czech. J. Phys.*, **1**, *No.* 3–4, 155–9 (1952).

Describes a method of successive approximation using graphical resolution of microphotometric curves formed by the merging of two diffraction lines with a known mutual ratio of intensities, if it can be assumed that the "character" of both lines is the same. The method was tried out in determining the lattice constant of mixed crystals of TiC–WC. A.

548.735.4

5147. On the basic assumptions and the validity of Zachariasen's sign relations in X-ray crystal analysis. E. F. BERTAUT AND R. PEPINSKY. Letter in *Acta cryst.*, **7**, 214–15 (*Feb.*, 1954).

A reply to Lavine's criticisms [Abstr. 7312 (1953)] of Zachariason's paper [Abstr. 4765 (1952)]. It is shown that Zachariason's assumptions are valid for structures of many atoms in general positions.

A. R. STOKES

548.735.4

5148. Atomic resolution in generalized crystal-structure projections. D. C. PHILLIPS. Note in *Acta cryst.*, **7**, 221–2 (*Feb.*, 1954).

See Abstr. 9173 (1952). The variation of resolution with order of projection is discussed, and it is shown that generalized projections can give improved resolution over ordinary projections. A. R. STOKES

548.735.44

5149. A method of determining the approximate structure if the position of a certain number of atoms is known. A. LÍNEK. *Czech. J. Phys.*, **1**, *No.* 3–4, 134–6 (1952).

Carrying out the Fourier synthesis with the coefficients $|F|^2 - |F^*|^2$, where $|F|$ is the amplitude of the structure factor and $|F^*|$ the amplitude of the structure factor for a structure differing from the wanted one by the fact that the position of one atom is not considered, a map is obtained having two groups of maxima symmetrical about the origin. Each of these groups is arranged similarly as in the Fourier map and the corresponding maxima are displaced towards the origin in such a way that the unknown position is at the origin. If in F^* the positions of a greater number of atoms are not considered, then a map is obtained which is composed of maps similar to the Fourier map with the unknown positions at the origin. If in F^* a certain position is assumed incorrectly then the group of minima of the map has a similar position as the maxima of the Fourier map and is displaced, the incorrect position being at the origin. If the Fourier synthesis is carried out with the coefficients $C = (|F|^2 - |F^*|^2) \sum_j \cos 2\pi(hx_j + ky_j + lz_j)$, $S = (|F|^2 - |F^*|^2) \sum_j \sin 2\pi(hx_j + ky_j + lz_j)$, where $x_jy_jz_j$ are the positions of the atoms considered, then the unknown position can be determined from the map. It is possible to extend this method to the general case when the position of all atoms is unknown. A.

548.735.44

5150. Application of the convolution to the Fourier analysis of crystals. J. L. AMORÓS. Note in *An. Real. Soc. Españ. Fís. Quím.*, **48(A)** 367–9 (*Nov.–Dec.*, 1952) *In Spanish.*

Pepinsky's method is applied to the structure of coronene, with the electron density in an atom represented by a function of form $(1 + \cos x)^8$. The transform of this function is tabulated. A. R. STOKES

548.735.44

5151. The interpretation of diffuse X-ray scattering from powder patterns of solid solutions. P. A. FLINN, B. L. AVERBACH AND P. S. RUDMAN. *Acta cryst.*, **7**, 153–8 (*Feb.*, 1954).

Methods are developed for the evaluation of the Fourier coefficients which measure the local order and the sizes of atoms in solid solution. A transform of the diffuse scattering from polycrystalline samples modified by an exponential weighting function is used to obtain these coefficients with a minimum of false detail. Two experimental examples are given. Measurements of the diffuse intensity in electron units from an aluminium-zinc alloy at 400°c show that zinc-rich clusters exist in the equilibrium solid solution above the solubility temperature. Simi measurements for a nickel-gold solid solution indica a preference for unlike neighbours above the so bility gap. In the latter system the diffuse intens produced by the difference in atomic radii is al observed.

548.735.

5152. The use of a high speed automatic calculat in the refinement stages of crystal-structure determin tions. T. R. THOMPSON, D. T. CAMINER, L. FANT W. B. WRIGHT AND G. S. D. KING. *Acta cryst.*, 260–9 (*March*, 1954).

The differential Fourier method and the method steepest descents have been adapted for iterati refinement of centrosymmetric crystal structur using a high speed automatic calculator. T methods have been applied to the refinement of t crystal structure of nicotinamide, which has 9 crysta lographically independent atoms and 939 observe *hkl* reflections. The differential refinement for structure of this complexity takes 35 min per iteratio and the steepest-descents refinement 40 min, i cluding the recording of the individual calculate structure-factor values on magnetic tape.

548.735.4

5153. A versatile projector for assisting in cryst structure determinations. W. R. PHILIPS AND D. MCLACHLAN, JR. *Rev. sci. Instrum.*, **25**, 123– (*Feb.*, 1954).

In the determination of crystal structures fro X-ray data, mathematical equations are frequentl used for which there are no physical analogues avai able. The introduction of physical analogues advantageous because they assign a physical signi ficance to the mathematics and, also, because the make possible the use of apparatus which either aid or replaces the long computations. In this paper description is given of an optical device which pro duces as photographic records the results of th mathematical processes known as convolutions Since there are several kinds of convolutions, an since the device is very versatile, the particular type of convolutions for which the apparatus is adaptabl are the well-known Patterson projection and, also, th mixed projections. The illustrations that are furnishe should aid in the understanding of some of the mor recently developed methods of structure determina tion. The apparatus is constructed of material readily available in any laboratory. A

548.736.

5154. X-ray determination of electron distributio in crystals. J. KRUG, B. WAGNER, H. WITTE AN E. WÖLFEL. *Naturwissenschaften*, **40**, *No.* 23, 599–60 (1953) *In German.*

Results of measurements on rock salt and LiF are given. The ionic radii of Na^+ and Li^+ are larger and those of F^- and Cl^- are smaller, than the values given by Goldschmidt and Pauling. A. R. STOKES

548.736.3

5155. The crystal structure of tantalum nitride TaN. G. BRAUER AND K. H. ZAPP. Note in *Naturwissenschaften*, **40**, *No.* 23, 604 (1953) *In German.*

Hexagonal, $a = 5{\cdot}181$, $c = 2{\cdot}902$ kX, $Z = 3$, Ta in 000, $\frac{1}{3}\frac{2}{3}\frac{1}{2}$, $\frac{2}{3}\frac{1}{3}\frac{1}{2}$, N in $\frac{1}{2}00$, $0\frac{1}{2}0$, $\frac{1}{2}\frac{1}{2}0$. These results

considered more reliable than earlier work; pure erials were used and the composition was checked nalysis. A. J. C. WILSON

548.736.3

5. Crystal structures of GaSe. K. SCHUBERT E. DÖRRE. Note in *Naturwissenschaften*, **40**, 23, 604–5 (1953) *In German.*

wo structures are discussed in the light of ubert's concept of *Ortskorrelation der Valenzelek-nen* (spatial correlation of valence electrons).

A. J. C. WILSON

548.736.3

57. Investigations on glassy SiO_2. H. RICHTER, BREITLING AND F. HERRE. Note in *Naturwissenaften*, **40**, *No.* 24, 621 (1953) *In German.*

From X-ray diffraction photographs a radial disoution curve was obtained, which is consistent th a structure made up of SiO_4 tetrahedra. The ge number of sharp maxima on the curve indicate nsiderable order in the structure. A. R. STOKES

548.736.3

58. On a new silicon dioxide modification with re structure and chain molecules. AL. WEISS AND R. WEISS. Note in *Naturwissenschaften*, **41**, *No.* 1, (1954) *In German.*

This modification was obtained from the reactions $SiO + O_2 \rightarrow 2SiO_2$ and $2SiO \rightleftharpoons SiO_2 + Si$ at 1200 1400°C. The crystals were orthorhombic ($a = 4{\cdot}72$, $= 5{\cdot}16$, $c = 8{\cdot}36$ Å). The space-group was found be $D_{2h}^{26} - I_{cma}$. The density was 1·97–1·98 and e melting-point near 1420°C. A. J. TAYLOR

548.736.3

159. The crystal structure of hydrogen fluoride. M. ATOJI AND W. N. LIPSCOMB. *Acta cryst.*, **7**, 173–5 (*Feb.*, 1954).

Hydrogen fluoride forms orthorhombic crystals in he space group D_{2h}^{17}–*Bmmb*, with four molecules in unit cell of dimensions $a = 3{\cdot}42$, $b = 4{\cdot}32$ and $= 5{\cdot}41$ Å. Infinite zigzag chains of hydrogen onds exist parallel to (100). The FH . . . F hydrogen-onded distance is $2{\cdot}49 \pm 0{\cdot}01$ Å, and the hydrogen-ond angle about fluorine is 120·1°. The anisotropic hermal motion of fluorine shows larger amplitudes of vibration perpendicular to the *y*-axis, the direction of the hydrogen bonds. A.

548.736.4

5160. The lattice constants of the alkali borohydrides and the low-temperature phase of sodium borohydride. S. C. ABRAHAMS AND J. KALNAJS. *J. chem. Phys.*, **22**, 434–6 (*March*, 1954).

The lattice constants of sodium, potassium, rubidium and caesium borohydrides have been measured at 25·0°C as $6{\cdot}1635 \pm 0{\cdot}0005$, $6{\cdot}7272 \pm 0{\cdot}0005$, $7{\cdot}029 \pm 0{\cdot}001$ and $7{\cdot}419 \pm 0{\cdot}001$ Å respectively. All four crystals are face-centred cubic and have the sodium chloride structure. Below the transition point (−83°C) sodium borohydride becomes tetragonal with lattice constants of $a = 4{\cdot}354 \pm 0{\cdot}005$ and $c = 5{\cdot}907 \pm 0{\cdot}005$ Å at −195°C. A.

548.736.5 : 537.226.2

5161. X-ray study of phase transitions in $PbZrO_3$ containing Ba or Sr. G. SHIRANE AND S. HOSHINO. *Acta cryst.*, **7**, 203–10 (*Feb.*, 1954).

The crystal structures of various phases in (Pb–Ba)ZrO_3 and (Pb–Sr)ZrO_3 systems, the dielectric properties of which were reported previously [Abstr. 5102 (1952)], have been studied by the powder diffraction method. A crystal structure of a ferroelectric intermediate phase in the (Pb–Ba)ZrO_3 system, which can be observed between the antiferroelectric (tetragonal) and paraelectric (cubic) phases found in pure $PbZrO_3$ when the Ba concentration exceeds 5%, is shown to be a rhombohedral modification of the perovskite structure with α slightly less than 90°. It is shown that, although the (Pb-Ba)ZrO_3 compositions from pure $PbZrO_3$ to (Pb95–Ba5)ZrO_3 do not show this intermediate phase, the application of a strong d.c. field can produce the rhombohedral phase just below their Curie temperatures. A crystal structure of an intermediate antiferroelectric phase in the (Pb–Sr)ZrO_3 system, which begins to appear when the concentration of Sr is as small as 1%, is found to have a tetragonal lattice with c/a slightly less than unity. The observed superlattice lines in this phase are different from those of the antiferroelectric phase in pure $PbZrO_3$. A.

548.74

5162. The spread of electron diffraction patterns. H. EHINGER AND C. MENZEL-KOPP. *Z. Phys.*, **136**, *No.* 2, 248–50 (1953) *In German.*

Previous attempts have been made to interpret quantitatively the "spottiness" of Laue electron diffraction patterns from thin single-crystal foils, and particularly to relate the angular width of the zeroth maximum to the crystal thickness, but have not been decisive owing to uncertainty as to possible deformation of the crystal [J. A. Darbyshire and R. Cooper, *Proc. Roy. Soc.* [*London*] *A*, **152**, 104 (1935); H. Raether, *Ergebnisse der exakten Naturwissenschaften*, **24**, 66 (1951)]. The method of diffraction with convergent electron beams has now been used to test the planarity of films of mica. By inserting an aperture the incident beam is then made effectively parallel and a normal Laue pattern obtained from a region of ~2 microns diameter. The diameter of the zeroth zone depends strongly on electron intensity. For standard conditions, its diameter is found to be constant for film thicknesses varying from 450 to 1100 Å; for thicker crystals (> 2000 Å) the diameter is distinctly less. A theoretical explanation of the results is given in terms of the differing dependence of the structure factor on the number of lattice points in the direction of illumination and on their spacing, respectively. V. E. COSSLETT

548.74

5163. The structure of thin zinc oxide films on the surface of single crystals of zinc (according to observations by electron diffraction). H. EHLERS. *Z. Phys.*, **136**, *No.* 4, 379–88 (1953) *In German.*

Zinc oxide films, grown on electrolytically polished (001) faces of zinc, were examined by electron diffraction. They were about 15 Å in thickness and showed no trace of any abnormal structure. The ZnO is so laid down, however, that the *c*- and *a*-axes of its structure are parallel to the corresponding axes of the Zn structure. Additional reflections are attributed to multiple scattering. An attempt to grow Zn single crystals by evaporation on to LiF *in vacuo* met with no success. J. THEWLIS

548.74

5164. A dynamical theory of the simultaneous reflexion by two lattice planes. I. Simple representation of the dispersion surface. K. KAMBE AND S. MIYAKE. Letter in *Acta cryst.*, **7**, 218–19 (*Feb.*, 1954).

A theoretical interpretation of the phenomenon of the simultaneous reflection of electrons from different planes of a single crystal. An analogous method is possible for X-ray diffraction. J. THEWLIS

548.74

5165. A dynamical theory of the simultaneous reflexion by two lattice planes. II. The effect of the phase factor of the structure amplitude. S. MIYAKE AND K. KAMBE. Letter in *Acta cryst.*, **7**, 220 (*Feb.*, 1954).

By an extension of the ideas put forward in the preceding abstract it is shown that, in principle, the relative phases of the structure factors may be obtained in the case of simultaneous electron diffraction by two crystalline planes. The argument is also valid for X-ray diffraction. J. THEWLIS

548.74

5166. Electron diffraction study of the structures of antimony electrodeposited on antimony cleavage face. LING YANG. *J. appl. Phys.*, **25**, 184–8 (*Feb.*, 1954).

Thin layers of antimony of average thickness ~100 Å, electrodeposited at 90°C and 2 mA/cm² on the (111) cleavage face (referred to pseudo-cubic axes) of an antimony single crystal, yield abnormal electron diffraction patterns. Analysis of these patterns shows that the deposit crystals are arranged in three azimuthal equivalent orientations, with their $(11\bar{1})$ instead of the (111) lattice planes parallel to the (111) antimony substrate. This is confirmed by comparing the patterns obtained experimentally with those constructed from the Laue zones of reinforcement of the electron beam scattered from three non-parallel atom rows. This observation is discussed in connection with the various factors controlling the crystal orientation in electrodeposited metals. A.

548

5167. Subsidiary maxima in electron-diffraction patterns from molybdenite. R. UYEDA, T. ICHINOKA AND Y. FUKANO. Letter in *Acta cryst.*, 7, 216– (*Feb.*, 1954).

Subsidiary spots on electron diffraction patte from thin single crystals of molybdenite are identifi as the secondary maxima of the interference funct in the dynamical theory. J. THEW

548

5168. Subsidiary maxima of Kikuchi patte R. UYEDA, Y. FUKANO AND T. ICHINOKAWA. Let in *Acta cryst.*, **7**, 217–18 (*Feb.*, 1954).

The work described in the preceding abstract extended to the case of the Kikuchi pattern. T occurrence of subsidiary fringes is explained in fashion analogous to the subsidiary maxima in th abstract. J. THEW

548

5169. A specimen heater for electron diffractio R. G. PICARD AND E. G. DORNFELD. *Rev. Instrum.*, **25**, 158–60 (*Feb.*, 1954).

An electric specimen heater for diffraction studies temperatures up to 1500°F is described. Specime up to ½ in. square may be heated by the element whi fits in the vacuum chamber upon the regular sta of an RCA-Type EMD-2 diffraction camera. T principal problem is the reduction of stray magne fields from heater wires to a negligible value. This achieved by using low current in high-resistance wi and reverse winding the heater coils. Radiation a conduction losses are cut to a minimum by enclosi the heater element in "Lava" except for a windo over which the specimen is mounted. D.c. power taken from the power supply for the valving syste

548.74 : 537.533.

Interference effect in electron microscope observ tions. *See Abstr.* 4597

548.74 : 539.18

On the scattering of slow neutrons by crystals nea the Bragg angles. *See Abstr.* 5005

GEOPHYSICS 55

550.341

5170. The effect of the earth's ellipticity on the precision of seismological calculations. V. KÁRNÍK. *Czech. J. Phys.*, **2**, 64–70 (1953) *In Russian. Summary (500 words) in English.*

Outlines the theory of the effect of the earth's ellipticity on travel times of seismic waves and gives Jeffreys' derivation of the differences between travel times through the earth and through a reference sphere of equal volume. The methods of applying these corrections at the Prague seismological station are described. A. H. COOK

550.341

5171. Screening action of a thin elastic layer. V. BABICH AND A. ALEKSEEV. *Dokl. Akad. Nauk SSSR*, **91**, *No.* 4, 763–5 (1953) *In Russian.* Englis translation, *U.S. National Sci. Found. NSF-tr-131.*

When a wave is propagated in laminated media, occasionally occurs that the wave is incident on a thi layer at an angle exceeding that for total interna reflection but, in spite of this, the disturbance partiall penetrates the screening layer. The penetratio becomes greater when the thickness of the layer i reduced and the angle of incidence approaches th critical value. The problem is studied theoreticall in the present paper, the solution of the problem i the theory of elasticity being constructed by th method of incomplete separation of variables. Fo simplicity, it is assumed that the velocities in th material above and below the screening layer ar equal and lower than that in the layer. It is foun

the results obtained cannot be explained by ries based on geometrical optics and it is con- ed that future progress in this field of geophysics ends on the full application of the dynamical ory of elasticity. A. C. WHIFFIN

550.38 : 537.311.1

2. Electron inertia and terrestrial magnetism. DARWIN. *Proc. Roy. Soc. A*, **222**, 471–6 (*March* 23, 4).

The problem is solved of the influence that electron rtia might have on the earth's magnetism. Owing the retardation of the earth's rotation electric rents will arise from it. Though the direction is rect, it is shown that even for a sphere of the great e of the earth the magnetic effect is entirely gligible. It is also shown that changes of the celeration rate would have to be extremely slow order that they should produce any effect at all en on this extremely weak field. A.

550.385 : 523.755

Coronal observations and magnetic storms. *See Abstr.* 4122

550.839

73. Radioactive prospecting for uranium minerals. . LALLEMANT. *Onde élect.*, **33**, 547–52 (*Oct.*, 1953) *French.*

Summary of principles with a table of properties of rincipal uranium minerals, followed by a review of pparatus developed by the Commissariat de l'Energie tomique. Prospecting for uranium minerals in rench territory is referred to. A. H. COOK

550.839

174. Electronic equipment used in geological vestigations in depth by radioactive methods. . BERBEZIER. *Onde élect.*, **33**, 553–60 (*Oct.*, 1953) *In rench*

Review of principles of radioactive borehole logging nd of apparatus developed in France. 11 refs.

A. H. COOK

551.46

5175. A discussion on the floor of the Atlantic Ocean. *Proc. Roy. Soc. A*, **222**, 287–407 (*March* 18, 1954).

Held in February, 1953, under the leadership of E. C. Bullard, the discussion deals with the great advances made in recent years in the geological survey and study of the Atlantic Ocean. There are 15 papers altogether. Those in Pt I cover work on the sediments of the Atlantic, including methods of obtaining core samples and the results obtained from their study. Pt II deals with the deeper structure and with the results of seismic observations.

551.46 : 536.2

5176. The flow of heat through the floor of the Atlantic Ocean. E. BULLARD. *Proc. Roy. Soc. A*, **222**, 408–29 (*March* 18, 1954).

The measurement of the temperature gradient and thermal conductivity in the sediments beneath the floor of the North Atlantic Ocean is described. Measurements were made at five stations. The mean heat flow and conductivity were found to be $0{\cdot}98\times10^{-6}$ cal/cm^{2}sec and 25×10^{-4} cal/cm. deg. c. sec. The heat flows at the individual stations range from $0{\cdot}58$ to $1{\cdot}42\times10^{-6}$ cal/cm^2 sec. The high heat flow is an unexpected result, and it is difficult to find a source for so much heat. A.

ATMOSPHERE . METEOROLOGY 551.5

551.501.7

5177. Rocket measurements of upper atmosphere ambient temperature and pressure in the 30- to 75-kilometer region. H. S. SICINSKI, N. W. SPENCER AND W. G. DOW. *J. appl. Phys.*, **25**, 161–8 (*Feb.*, 1954).

A method for determining ambient temperature and ambient pressure in the upper atmosphere is described, using the properties of a supersonic flow field surrounding a right circular cone. The underlying fundamentals stem from basic aerodynamic principles as combined with the developments of the aerodynamics of supersonic cones by G. I. Taylor, J. W. Maccoll and A. H. Stone. The experiment provides the necessary cone pressures, velocities and Eulerian angles, such that a Mach number characterizing the ambient space conditions may be computed. A description is given of the requisite experimental equipment and related techniques. Experimental data from two rocket-borne equipments are presented with the resulting calculated pressures and temperatures as experienced over New Mexico to approximately 70 km. A.

551.501.7 : 551.594.14

5178. Possibility of high performance with a new kind of glider. H. GARRIGUE. *C.R. Acad. Sci. [Paris]* **238**, 264–6 (*Jan.* 11, 1954) *In French.*

For prospecting atmospheric radioactivity in the region of Puy de Dôme an aircraft was modified so that it could operate up to 6000 m or more. It then acts as an object in equilibrium in space and follows the ascending or descending air currents encountered. Details are given of one flight in a southerly current when at 6050 m the aircraft was still ascending at 2 m/sec and there was no turbulence. By choice of launching site and using the ascending currents a glider can make a long flight in conditions different from those hitherto considered. The whole problem resides in the arrangement of a glider with stratospheric characteristics. R. S. READ

551.501.8 : 522.6

The application of radar to meteorology. *See Abstr.* 4099

551.501.9

5179. National Bureau of Standards Mobile Low-level Sounding System. P. D. LOWELL, W. HAKKARINEN AND D. L. RANDALL. *J. Res. Nat. Bur. Stand.*, **50**, 7–17 (*Jan.*, 1953).

This is a combination of an improved wired sonde and an Army SCM–1A mobile weather station. Its purpose is to measure temperature and moisture distributions and their associated gradients and heights from near the ground up to a maximum height of 2000 ft over different types of terrain. The system has six distinguishing features: 1. Balloon-level heights can be determined at all times during a flight by data recorded at the ground level by an

electric altimeter. 2. Humidity data recorded with this system, which is energized with 60 c/s a.c., are reliable for longer periods of time than those obtained by d.c. sounding systems. 3. The system can be operated from within the heated truck body and is suitable for use in dense fog, at night or during very cold weather. 4. The air-borne unit is of lighter construction because switching and ventilating of the circuit-measuring elements are done by a gravity motor instead of a battery-driven motor. 5. The system provides a condition of radio silence during operation. 6. The system is designed to operate into recorders requiring up to 500 μA d.c. The intelligence from the system can therefore be recorded directly on the equipment in a standard radiosonde receptor installation. A.

551.510.535

5180. Measurement of winds in the ionosphere. G. J. PHILLIPS. *J. atmos. terrest. Phys.*, **2**, *No.* 3, 141–54 (1952)

The fading of an ionospheric echo at several receiving points on the ground has been used to measure the velocity of horizontal movement in the ionosphere. A systematic series of observations has been made for a period of over two years, on a frequency of 2·4 Mc/s. Reasons are given for supposing the results to refer to the motion of the air at heights in the range 100–120 km. Regular daily and seasonal changes of direction were found, partly attributable to a solar tide having an amplitude of 16 Mc/s. The observed phase of this tidal motion is not consistent with the simple dynamo theory of geomagnetic quiet-day variations. Remaining changes of a less regular nature suggest that rapid variations of wind at a fixed level, or differences in wind at closely separated levels, may occur. A.

551.510.535 : 523.748

Solar spicules and their role in solar phenomena. *See Abstr.* 4118

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 4751–5

551.510.535 : 621.396.11

5181. Some results concerning the critical frequency and the transmission factor of the *F*-1 ionospheric layer. E. THEISSEN. *C.R. Acad. Sci.* [*Paris*] **237**, 1104–6 (*Nov.* 2, 1953) *In French.*

f_0F1 and $M3000$ data for the Fribourg station (lat. 48·1°N, long. 7·8°E) have been studied for the period 1946–1952. Writing $f_0F1 = k \cos^n \chi$ [χ solar zenith angle], n is calculated to be 0·22. In the case of $M3000$ the seasonal and diurnal variations follow the law $M_0 \cos^m \chi$ with $m = 0{\cdot}08$. W. J. G. BEYNON

551.521.3 : 551.575

5182. Researches on the propagation of visible and infrared light through haze and fogs. A. ARNULF, J. BRICARD AND C. VERET. *C.R. Acad. Sci.* [*Paris*] **238**, 503–5 (*Jan.* 25, 1954) *In French.*

The optical density per kilometre over the spectral range 0·3–10 μ was measured for a number of fogs and hazes. Hazes have a low optical density (<2/km at 0·4 μ) and are selective, having greater transparency in the infrared. Fogs have larger optical densities, 10/km, and are less selective than hazes.

R. W. FISH

551.59

5183. Reflections on a corpuscular theory of emiss from the night sky. P. SWINGS. *Scientia* [*Asso*] *No.* 1, 5–12 (1954) *In French.*

The suggestion is made that certain emission featu in the night-sky spectrum due to O, Na, O_2 and originate at high altitudes around 200 km, and res from collisions between atmospheric and ext terrestrial particles (protons of energy 10 kV) with production of a semi-permanent low-energy auro discharge. D. R. BARE

551.59

5184. Correlation between the intensities of the doublet, and the (6, 1) band of OH during the nig P. BERTHIER. *C.R. Acad. Sci.* [*Paris*] **238**, 263 (*Jan.* 11, 1954) *In French.*

Photographic spectrophotometry of the Na *D*-lin at 5893 Å, and the *R*-branch of the (6, 1) band of O at 6470 Å has established a striking parallelism of t intensities of these emission features of the night-s spectrum during 6 nights in September, Novemb 1952. D. R. BARB

551.5

5185. Atmospheric electricity. J. A. CHALMER *Rep. Progr. Phys.*, **17**, 101–34 (1954).

A number of current problems in atmospher electricity are discussed in turn; these are: ionizatio equilibrium in the atmosphere; fine weather fields ar currents, particularly conditions close to the earth surface; point discharge; precipitation currents ar their origin; the maintenance of the charge on th earth; the electrical structure of thunderclouds an theories of the origin of charges in clouds. A

551.594.1

5186. Negative electric fields in mist and fog. J. A CHALMERS. *J. atmos. terrest. Phys.*, **2**, *No.* 3, 155– (1952).

The investigation, with transportable apparatus, o the occurrence of negative electric fields durin periods of mist and fog has shown that the effect mus be ascribed to the emission of an excess of negativ ions from overhead high tension power cables i damp conditions, probably during discharges over the insulators. A

551.594.12 : 537.563

Production of unipolar air. *See Abstr.* 4647

551.594.13

5187. The variation of electrical conductivity of air within sealed rooms. L. G. SMITH AND G. F. SCHILLING. *J. atmos. terrest. Phys.*, **4**, *No.* 6, 314–21 (1954).

The electrical conductivity of air within sealed rooms has been found to increase regularly, with some fluctuations superimposed, towards a limiting value. This variation is compared with Schweidler's theory of ion-equilibrium and the increase in conductivity attributed to a decrease in Z, the total concentration of nuclei. It is deduced that the rate of change of Z can best be represented by $dZ/dt = -\psi Z^{3/2}$ where ψ is a constant with the value $2{\cdot}5 \times 10^{-7}$ cm$^{3/2}$ sec^{-1}. This equation is shown to be close to that obtained by Nolan from direct observations of nuclei. A.

551.594.223

8. Model tests on ball lightning. H. NAUER. *angew. Phys.*, **5**, *No.* 12, 441–50 (1953) *In German.*

Several older theories to account for ball lightning are examined experimentally and are found to be unsuitable or insufficient to explain the observed properties of the natural phenomenon. Following an observation by H. Hertz a careful investigation is made of discharges in an evacuated vessel which are capable of producing self-luminous clouds which persist for measurable times. These clouds are found to be caused by the burning of small amounts of a variety of gases, particularly methane. The properties of the experimentally produced phenomena are compared in detail with those of ball lightning. The investigation also leads to an explanation of "Flächenblitzen." R. H. GOLDE

551.594.5

89. Radio echoes observed during aurorae and geomagnetic storms using 35 and 74 Mc/s waves simultaneously. L. HARANG AND B. LANDMARK. *atmos. terrest. Phys.*, **4**, *No.* 6, 322–38 (1954).

Observations have been made at Kjeller (near Oslo) and at Tromsoe (near the auroral zone) using pulse transmitters operating simultaneously on 35 and 74 Mc/s. The presence of echoes was closely connected with geomagnetic and auroral activity but there was no correlation between the position of the aurora in space and the range of the echoes. Further, when the aerials were pointed at intense auroral forms no echoes were received. Echoes could only be observed when the aerials were directed at a low angle of elevation towards the North. It is concluded that these echoes are not due to direct scatter from the ionosphere or from auroral structures, as assumed previously, but can only be explained as back scatter from land or sea after reflection at an intense E_s layer formed along the auroral zone during aurorae and geomagnetic storms. An analysis of the characteristics of the echoes and the differences in the echo ranges on 35 and 74 Mc/s support this hypothesis. Different types of echoes are described and the results of polarization measurements summarized. Correlation in time between the echo amplitudes is studied by means of double-pulse modulation, the time interval between the pulses being variable. Possible passive radiation from the aurora in the 10 cm band could not be detected with the equipment available. A.

551.594.51 : 535.338.4

Excitation conditions for the infra-red aurorae bands of ionised nitrogen. *See Abstr.* 4349

551.594.6 : 538.566.3

5190. The mechanism and distribution of short period fading under conditions of ionospheric turbulence. F. MINOZUMA AND H. ENOMOTO. *Proc. Phys. Soc.* [*London*] *B*, **67**, 211–16 (*March*, 1954).

Fading phenomena are discussed in terms of the variations of optical paths produced by the turbulent ionosphere. A simple model of turbulence in the ionosphere can predict the fading speeds found in practice, and some of the physical constants involved can be deduced from the variation of field intensity with time. The technique can be applied to determine fading speed and the amplitude distributions needed for communication purposes. A.

551.594.7 : 621.396.11

5191. A statistical survey of atmospheric index-of-refraction variation. C. M. CRAIN, A. W. STRAITON AND C. E. VON ROSENBERG. *Trans Inst. Radio Engrs Prof. Group on Antennas and Propagation*, **AP-1**, 43–6 (*Oct.*, 1953).

This paper presents a statistical survey of index-of-refraction variations as recorded by an airborne microwave refractometer. Scales and intensities of the index variations are given, as well as the parameter $\overline{\Delta N^2}/l$, for data taken over southwest Ohio during summer months and over the Pacific Ocean off the west coast of Washington in August and of California in October. Heights from 2000 to 25 000 ft were considered with most of the data taken between 2000 and 12 000 ft. Approximately 1200 samples taken on 34 flights were analysed. The composite of the data give the following median values: Index Scale = 130 ft; Index Intensity = 0·3 N; $\overline{\Delta N^2}/l = 7\times10^{-4}N^2$/ft. A.

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612 : 53

5192. Physics in physiology. P. L. MCLAIN. *Amer. J. Phys.*, **22**, 125–9 (*March*, 1954).

The importance of physics to the physician is discussed. A.

615.832.4 : 621.3.011.22 : 621.3.011.5

5193. Capacity and conductivity of body tissues at ultrahigh frequencies. H. P. SCHWAN AND KAM LI. *Proc. Inst. Radio Engrs*, **41**, 1735–40 (*Dec.*, 1953).

Electrical data are presented for a number of tissues over a frequency range from 200–900 Mc/s. The temperature coefficient of permittivity and resistivity is determined for various tissues over the same frequency range. An analysis is given which explains the frequency behaviour and the temperature coefficients of both permittivity and resistivity of water content. It is presented in terms of parameters which characterize the inhomogeneous structure of the material, the polar properties of water molecules, and the protein content. The results show the similarity of the dielectric properties of all tissues with high water content and whole blood. Previously formulated opinions concerning the relative heating of fat muscle layers with radiation diathermy are, therefore, justified. A short description is given of the measuring technique and a tissue sample thermostat. A.

612.843.63

5194. Receptor grouping in the retina. M. AGUILAR AND J. YUNTA. *An. Real Soc. Españ. Fis. Quím.*, **49**(A) 281–90 (*Sept.–Oct.*, 1953) *In Spanish.*

Various theories attempting to explain the intensity variation of visual acuity are critically reviewed and rejected. Otero's theory of the variable conductivity of amacrine cells is elaborated and found to be supported by some simple tests involving acuity measurements with the dark-adapted eye. [The bibliography is unreliable.] R. A. WEALE

612.845.3

5195. Night astigmatism. IV. M. AGUILAR AND M. J. YUNTA. *An. Real Soc. Españ. Fis. Quím.*, **48**(A) 244–5 (*July–Aug.*, 1952) *In Spanish.*

Anomalous results found in measurements on night astigmatism are ascribed to irregularities in the retinal mosaic. R. A. WEALE

615.849

5196. Isodose distributions for a 1,100-curie cobalt 60 unit. S. O. FEDORUK, H. E. JOHNS AND T. WATSON. *Radiology*, **60**, 348–54 (*March*, 1953).

The unit is described briefly [but see Abstr. 3 (1952)]. The source is 2·5 cm in diameter 1·25 cm thick, giving at 80 cm distance 33 r/m Penumbra effects are minimized by suitably desig Pb treatment cones. Isodose curves in a wa phantom for 12 different-sized fields, and a cen axis depth-dose table, are given. Composite isod curves for irradiation of the parametria are sho Isodose curves compare favourably with those 2–3 MeV X-rays. D. V. MA

615.8

5197. Observations of the scattered radiation ins and outside a 1,000-curie teletherapy room. J. BROWN. *Radiology*, **61**, 82–7 (*July*, 1953).

The amount of scattered radiation, noting the eff of dose rate, field size and phantom size, has be determined experimentally. The length of time t shutter is open, and its effect on the amount of rad tion outside the room are discussed. The variation h.v.l. of the scattered radiation outside the room given. D. V. MAB

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771.53 : 548

5198. Does the lattice constant of silver bromide alter on illumination? H. JUNGHANSS AND H. STAUDE. *Z. wiss. Photogr.*, **48**, *No.* 7–9, 194–203 (1953) *In German.*

An account is given of Huggins's views that a partial change of lattice type should occur in AgBr on exposure to light; previous experimental work is briefly reviewed. Instead of measuring lattice constants, the present authors made density determinations on large single crystals of AgBr, using bromoform as the immersion liquid. Pure crystals were used as controls, and those exposed to light were sensitized by incorporation of small amounts of Ag_2S or $CdBr_2$. The results were negative, since even with strong photolysis the density changes indicated that the fraction of the rock salt lattice changed into the zinc blende lattice could not be more than $2{\cdot}5\times10^{-5}$. S. T. HENDERSON

771.533 : 539.27

Electron microscope study of photographic grains. *See Abstr.* 5031

771.534 : 535.37

5199. The effect of pressure on the sensitivity an fluorescence of the photographic emulsion. A. BRAU *Czech. J. Phys.*, **1**, *No.* 3–4, 171–84 (1952).

Gives a survey of all known pressure effects on th photographic emulsion, particularly the temporar desensitizing effect, and briefly deals with the know fluorescent phenomena of photographic layers Experimental results are given of research on per manent pressure desensitization and its dependenc on pressure, the wavelength of the light used and th photographic material. A proof is submitted of th irreversibility of permanent pressure desensitization A lowering of the intensity of fluorescence of th photographic emulsion through the influence o pressure is described. All experimental results ar explained on the basis of existing conceptions on th origin of the latent image as well as of fluorescen phenomena. A

778.34 : 537.534.75

Range-energy relation of nuclear emulsions of different composition. *See Abstr.* 4622–3